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Professional Status

(A Guest Editorial)

J. C. HUNSAKER*

Massachusetts Institute of Technology

SOCIETY ACCORDS professional status to a group of persons who possess a body of special knowledge and apply it with superior skill in accordance with a recognized standard of conduct. By implication, admission to such a professional body is based on certain standards of education, experience, and character. These standards for admission are established and applied by the professional society, which acts on behalf of its members to uphold their own professional status and to advance their knowledge and skill.

Elevation of an individual's professional status comes from recognition by his fellow professionals. The prerequisite, therefore, to professional status for an individual is a professional body of which he can become a part.

It is not enough that a man have knowledge and skill if he is not to be trusted. Nor is it sufficient that he be licensed to practice by the State, for such licenses ordinarily represent minimum formal qualifications for the protection of the public. Professional status, in a given field, comes only from acceptance by those who are in a position to judge.

Any interested person can call himself an aeronautical engineer. But training and experience alone are vocational rather than professional. He may make a good employee or technician if he has some particular skill, but he will not necessarily be accorded professional status. The difference lies in his intellectual attitude; how he regards himself. The professional attitude includes a sense of responsibility over and beyond the demands of the immediate job. It includes a scrupulous regard for the interests of client or employer and a fine sense of honor with regard to professional colleagues. The professional attitude is impersonal rather than self-seeking. It can be distinguished by recognition of an obligation to share technical skill with others and to contribute to that body of special knowledge in the keeping of his professional group.

The Institute of the Aeronautical Sciences was founded to give professional status to aeronautical engineers and others working in the various fields of science applied to aeronautics. The professional character of the Institute is now recognized throughout the world and, consequently, carries the presumption of professional status for its members.

While admission to this professional group certifies qualifications, membership that is limited to mere dues-paying is hardly a guarantee of professional status and still less of professional recognition. Codes of ethics, written or unwritten, do not by their passive acceptance constitute a professional attitude. No more does joining a church make a Christian. Some further effort is required.

The professional considers himself a professional. He makes a conscious effort to improve his status in his chosen profession. He is proud of his profession, proud of his participation in it through the Institute, and active in its advancement. His day's work is done with a keen sense of an obligation for excellence in its accomplishment, but beyond this the professional aeronautical engineer sees a wider horizon. He is not just a man with a job, but a member of the Institute of the Aeronautical Sciences, the corporate body of his professional colleagues. Through this association he raises his head above the tall grass of daily chores to view the whole scope of an art and a science. He learns what his colleagues do and think. He learns to know and to evaluate the work of the current leaders in his profession. He may participate in discussions that may clarify his own problems and may himself contribute to the clarification of the problems of others. In fact, he may aspire to become, one day, a leader himself—a leader in the profession to which he is proud to belong.

This is all by way of advice to young aeronautical engineers from a schoolmaster. Join the Institute—if it will have you. Join in the local activities of your fellow members, study the JOURNAL, and read the REVIEW to learn what is going on outside your own job. Above all, realize that you have a profession and that you can advance in it through your conscious effort to achieve a professional attitude toward yourself, your employer, and your Institute.

* Head, Department of Mechanical Engineering and Department of Aeronautical Engineering.

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Regulation for Light Aircraft for Private Use

EDWARD WARNER*
Civil Aeronautics Board

Introduction

Government regulation exists to protect the innocent. It has no other reason for being. It exists to the end that each of us may be protected against willful negligence, recklessness, selfishness, or antisocial conduct on the part of our neighbors. The Civil Aeronautics Board has recently put out, for public consideration, the proposal that it is not part of the responsibility of civil air regulation to protect the citizen against himself, where no danger or distress to others than himself is involved. The response to that proposal has been overwhelmingly favorable, and I am writing here on the assumption that it foreshadows the governing principles of future regulatory development.

The regulation of the light airplane may relate to its design and construction, to the manner of its use, or to the qualifications of the personnel who use it. Our primary interest here is in design and construction, the fields of the aeronautical engineer, but I do not want to lose the opportunity of expressing some views of my own on the regulation of the operations of the completed aircraft.

Degrees of Governmental Control

On the general principle of protection of the innocent it is reasonable to maintain varying degrees of governmental control over various types of operation. It is universally agreed, and in fact it is recognized in the Civil Aeronautics Act, that the highest standards must be maintained in scheduled air transportation. Other types of commercial service, such as the conduct of charter operations or of flight training, involve varying degrees of public responsibility for the protection of the patron of the service, the responsibility being greatest in those cases in which the patron is least likely to be in a position to protect himself. In the purely private use of aircraft the public interest in the control of operating practice is reduced to a minimum, except insofar as such practices may endanger other users of the airspace or the innocent passer-by on the ground.

Certification of Private Aircraft

It is one of the most fundamental of my own convictions, therefore, that a clear distinction should be recognized between purely private flying and commercial use of any sort and that the distinction should be given practical

effect by establishing different grades of certifications of aircraft corresponding to the differences that already exist in the grades of certification of pilots. I hope that the establishment of a special certification and a distinctive type of identifying symbol for noncommercial aircraft, which, under the procedure I suggest, could not legally be used commercially without recertificating them in a different category, will gain enough public support to justify its early incorporation in the official rule book.

A short time before the war so sharp a regulatory distinction between private aircraft and those eligible for some sort of commercial use might have been more trouble than it would have been worth. A great proportion of what were loosely called "private aircraft" were, in fact, being used from time to time, if not continuously, for giving flight instruction, for carrying sightseers during week-ends, or for similar business. The aircraft that were used exclusively for pleasure and personal travel were certainly in the minority of the total number certificated—and probably a small minority.

In years to come, however, if even the most conservative projections of the future have any validity at all, purely private use will be the typical case. The private user may not be so overwhelmingly dominant as on the highways, where the Bureau of Public Roads reports that only 0.46 per cent of all registered passenger vehicles are used as taxicabs or otherwise available for hire, but there is little doubt that private aircraft will come to constitute a substantial majority of the total registration. The ordinary owner will never think of the possibility of giving instruction, of carrying passengers for hire, or of renting his aircraft to local flying services or schools for commercial purposes on crowded week-ends. His aircraft will be a private convenience, and its regulatory status can be established accordingly. As a first step in that direction it can be unmistakably and permanently identified as being in the private category.

Periodic Governmental Inspection

The logical consequence of such a segregation and identification of private aircraft would be, for those cases, a substantial relaxation of the standards of periodic governmental inspection or even a complete abandonment of any requirements on that point. The suggestion of complete abandonment of governmental inspection for recertification stands, at first sight, in contradiction of the insistence of many states upon periodic official inspection of motor carriers; but the two cases present no proper parallel, for the hazard that pedestrians and other motorists encounter on the highway is largely enhanced by defects in a car's brakes or lights, whereas the danger that a private aircraft presents to persons other than the occupants is almost entirely dependent upon the behavior of the pilot. It is affected only in a small degree by the condition of the aircraft itself. So far as the condition of particular items of equipment does substantially affect the safety of others—as, for example, the running lights and certain pieces of radio equipment—a periodic check of some sort should continue.

Limiting Speeds and Loads

Another question of fundamental principle for the future concerns the regulatory status of such information regarding limiting speeds and loads and allowable maneuvers as is now embodied in certificates and placards. Clearly, it will remain an offense against the law to carry loads beyond the certificated value on any aircraft used in a service for which public patronage is sought or to operate such an aircraft beyond the authorized limits of speed. Should the same rule apply in purely private operation? Considering the desirability of keeping regulation as simple as possible and of keeping policing responsibilities to the minimum compatible with the public interest, I do not personally think that it should. For the private user, it is my opinion that information on the loads and speeds for which the aircraft is designed and tested should

Presented at the National Light Aircraft Meeting, I.A.S., Detroit, April 27–28, 1944.
* Vice-Chairman.

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be given in full and in the clearest possible form. Everything possible should be done in the course of his training as a pilot and by subsequent injunction, adjuration, and educational effort to convince him of the wisdom of keeping his personal practice to well within the safe limits. But if the private owner, thus fully instructed and warned, is willing to run the personal risk of violating load limits or speed limits and if so incautious an individual has friends who are desirous of submitting themselves to the perils of participation in his flights, it does not seem to me an appropriate permanent obligation of Government to seek out legal proof of his folly and to hale him into court. On that point I would trust the law of self-preservation rather than regulations made by man, and I believe that a given amount of effort expended in education on the effects of overloading would have a better net effect on the total safety record of private flying than would the same amount devoted to the policing and the legal proceedings that make up enforcement. I am speaking only for myself in this matter and not for the Civil Aeronautics Board as an agency. I am proposing the subject as one deserving discussion, and I know that it will be helpful to all of us to have the views of interested parties on the lengths to which future regulation of the use of private-owner aircraft should be pressed and on the form that any such regulation should take.

The Designer and Manufacturer

Let me now concentrate on the regulatory prospects directly involving the designer and manufacturer of the aircraft and its auxiliary equipment. What limitation should be placed upon the characteristics of equipment that is to be placed on sale in the private market?

Recalling the attempts that I have already made to define the various degrees of public interest and governmental responsibility in this field, it seems to me that the primary purposes of airworthiness regulation for private aircraft are:

(1) To ensure that the articles sold are of sufficiently uniform quality to enable the user to count on their measuring up to the standard performance of the type and, in particular, that they are free from hidden flaws that might cause sudden unpredictable failures.

(2) To ensure that they possess no features, either of inclusion or of omission, that would especially predispose them to involvement in collisions either in the air or on the ground.

(3) To develop full information on the aerodynamic and structural qualities and the general behavior of each new type of aircraft, so far as those points affect safety, with such information to be made available for the guidance of every user.

(4) To ensure that aircraft placed upon the market include no characteristics that would create hazards beyond the power of a pilot's skill to overcome or any substantial hazard even to the relatively unskilled unless the elimination of such characteristics appears incompatible with the securing of other advantageous qualities.

Uniformity in Quality of Materials

I presume that the first of these points needs no argument. I presume that everyone agrees that aircraft for any purpose must always be built of materials the properties of which are determinate within a narrow range. Control during construction must ensure against unwitting incorporation of elements defective in basic physical properties or in workmanship. There should be an equally ready acceptance of a prohibition of any use of methods or materials that are apt to suffer serious deteriorations in service in ways that cannot be detected by any feasible means of inspection. At least I shall assume that there is universal agreement on those points, which have long been implicit in all airworthiness regulations.

Avoidance of Collision

The second point concerns the avoidance of collision, and here we deal with a hazard which was of almost negligible significance in the early days but which has been steadily growing in importance in recent years and now presents alarming possibilities for the future.

Only a few years ago collisions between aircraft in flight were isolated and widely spaced occurrences. From 1928 to 1935, inclusive, with practically no traffic control of any sort in use, there were an average of only 5.8 collisions per year in the United States. Since the great expansion in training activity began during the present war, they have become increasingly frequent. A tabulation prepared by the Civil Aeronautics Board's Accident Analysis Section shows 14 such collisions in 1941, 18 in 1942, and 31 last year, making a 3-year total of 63. None of these figures includes collisions between military aircraft, although they do include those in which a military and a civil machine were involved.

All but ten of the 63 accidents occurred in training, which is perhaps no more than might be expected in view of the vastly preponderant contribution of training to total civil flying hours during this particular period. Eight of the total number involved either acrobatic or formation flying, while twelve were collisions between machines being used in practicing less violent maneuvers, with the pilots presumably intent upon perfecting their technique in a practice area where they supposed themselves to be alone. This still leaves 43 collisions that occurred either in normal cruising or during take-offs, approaches, or landings. The approach for landing was the period of greatest hazard, with 21 collisions occurring during that comparatively brief maneuver.

Causes of Collisions

What causes collisions? Carelessness and inadequate training certainly contribute in many cases, and errors in the direction of traffic at airports have played an occasional part. But the greatest cause is the limited range of cockpit vision. Attention must be concentrated on this factor if collisions are not to continue to increase in number, and increase more rapidly than the total number of aircraft or the total amount of flying.

In instance after instance among the collisions of the last two years, it has appeared that both pilots were following a normal course and keeping a normal lookout—about as good as it would be reasonable to expect them to maintain. Then they collided, without either one having seen the other until they felt the impact. The most common of all are the cases of collision: (1) between two aircraft that are both turning in the same direction, either on arcs of different radii or simply on intersecting paths of about the same curvature, or (2) between an aircraft following a straight course and another one coming up from behind at higher speed and at the same time turning into parallelism with the course of the aircraft which it ultimately struck. The case of two aircraft turning in opposite directions on intersecting paths could be still more dangerous but seldom arises, whereas the simultaneous turning of two or more aircraft in the same direction is a necessary incident of every airport traffic pattern.

Designing for Vision

It would be a useful piece of research, which I hope someone will undertake, to take model aircraft of varying types and move them about with respect to one another to determine just what relationships of position and attitude will put each in the blind spot of the other. It does not need any exhaustive study, however, to reach some tentative conclusions. It seems clear, for example, that a wing over the pilot's head is a major source of blind area in a turning aircraft and that it can be all the more dangerous because even experienced pilots are not always fully conscious of the critical location of the blind area so created. It is obvious that the difference in form between two aircraft may create a special hazard, as in the rudimentary case of a high-wing machine climbing up underneath one of low-wing type, the two paths converging vertically and each pilot remaining continuously in the other's blind area. Defective vision directly forward is relatively less of a hazard now than it was a few years ago when pilots were customarily placed well back in the fuselage, but the same shift of pilot location that has reduced the hazard of head-on collision or of running another airplane down from behind has reduced vision to the rear to such an extent that it now presents a grave problem.

Standards of Vision

I do not know how far this can be considered a matter for regulatory treatment. No one would wish to establish regulations that would seriously limit a designer's freedom of choice with re-

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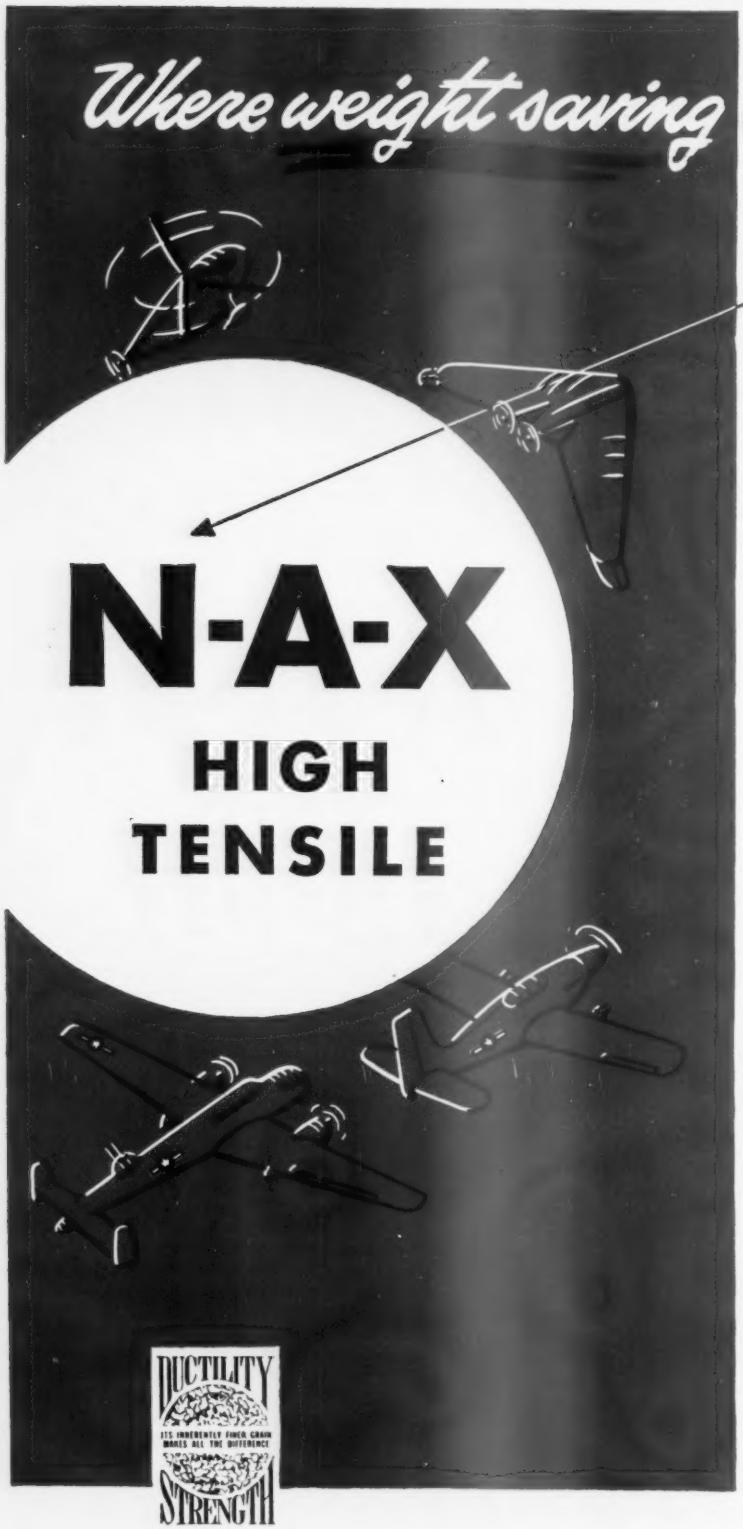

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spect to the relation between wing and fuselage except upon a clear showing that such a restriction was absolutely necessary in the avoidance of a grave and otherwise inevitable hazard. Whether the problem is to be attacked by regulation or by manufacturers' own recognition of their responsibility in the matter and resultant voluntary action, however, we certainly ought to be giving more attention than in the past to the definition of the desirable extent of visual area. Unfortunately, the operation of an aircraft having blind areas that are too large or in the wrong places is a hazard not only to the operator but to all the other users of the neighboring air space. I suggest, as another subject of discussion by the industry, the future development of visual area and the means that should be adopted to ensure against the operation of aircraft with dangerously restricted vision. As a starting point, I propose as desirable that vision be completely unobstructed within the space enclosed between the upper part of a plane perpendicular to the normal line of flight and the forward part of a plane inclined 20° below the normal line of flight, giving a clear field of view through a dihedral angle of 110°. There should also be an area of clear vision extending over a lateral angle of at least 20° on each side of the plane of symmetry of the airplane and extending from the vertical back to the horizontal. That, I repeat, is merely to start the discussion. I hope that we shall have much further consideration of the actual form of specification to be drawn along those general lines, to ensure pilots enough freedom of vision to permit them to avoid collision. There should also be a discussion of the means whereby such a specification can be met in an aircraft that is otherwise satisfactory. Builders of high-wing monoplanes in particular need to give consideration to the problem presented by that location of the wing and to the determination of the range of fore-and-aft and vertical location within which the pilot's eye must be placed so that the area cut off from vision by the wing overhead may present a minimum of hazard. The more extensive use of methyl acrylate or other transparent plastics for covering center sections or other strategically chosen portions of wing and fuselage is among the obvious possibilities, and rearview mirrors may also be so developed as to contribute to the solution of the problem.

Training of Personnel

Whatever may be done to improve the visual area of aircraft, the proper training of personnel in the keeping of a proper lookout will remain one of the critical factors. It certainly is of the utmost importance that every pilot be taught to be respectful of his own blind areas and to appreciate the location of the blind areas of other aircraft of various types. Then he may keep a special lookout in those areas in which another aircraft might appear on a path convergent with his own and with the other pilot unable to see him.

Traffic Control

One thinks first of collision in terms of aircraft that are in visual contact, or would be if it were not for their blind areas, but another set of collision problems arise in the overcast. In that connection the present type of traffic control is certainly going to have to be supplemented, as great increases in traffic occur, by additional installations in the airplane itself for avoiding collisions when on instruments. It is impossible to go into detail at the present time, but it seems altogether probable that certain devices intended for that sole purpose will have to be carried on every aircraft or, at least, on every one that is in the slightest degree likely ever to get into conditions of low visibility. The installation and maintenance in proper working condition of any such equipment should then be a matter of continual expert supervision. We shall know more about that after we have seen another year or two of electronic development and after the now mysterious triumphs of electronic research during the war become the subject of public discussion.

Determination of Performance Characteristics

The third of the legitimate objectives of airworthiness regulation for private airplanes is the supplying of the pilot with information. Safety in flight is less dependent on the existence of any particular characteristics in an aircraft than on keeping the use of every aircraft properly within its own safe limits. It is not in the fact that the take-off run for a particular airplane may exceed a particular arbitrary value that danger lies, but in the attempt to make the take-off from a smaller field than the particular airplane requires. There is as great a likelihood of accident (although the consequences of the accident may not be so serious) from attempting a landing in a 600-ft. field with an airplane that needs 800 ft. as from trying to get down on a 3,000-ft. runway with a machine that needs 4,000 ft.

It should then be the universal rule that certain elements of performance—especially those relating to take-off distance, landing distance, and rate of climb—be accurately measured and officially certified. It should be the rule that the handbook provided with each aircraft include a thorough discussion of its flying qualities and that the process of testing for an airworthiness certificate include a check of the accuracy and completeness of the material presented on the behavior and handling of the aircraft—on the ground and in the air. Needless to say, the pilot's manual for each type should also discuss load and speed limits, as well as the magnitude of the load factors allowable under various conditions.

Exclusion of Inherently Dangerous Features

The last on my list of the functions of regulation is the exclusion of features that would be inherently dangerous. I can best give my own view of its practical meaning by citing two extreme examples—one at either extreme.

At one extreme is the obvious undesirability of allowing the sale of aircraft that would have a special inherent liability to disastrous fire in flight. That is a hazard with which no skill on the part of the pilot can be expected to cope, and it is one that no purchaser or pilot in his right mind would be expected to accept if he fully realized its presence. No such airplane should be certificated. None ought to be certificated which would present a risk of the accumulation of carbon monoxide in the cockpit. None should be allowed on the market which possesses structural factors so low that the structure could not withstand the ordinary stresses of cross-country flying through ordinary turbulence.

The opposite extreme was brought to my attention, at a meeting where I recently spoke, by a suggestion from the floor that, in the future, the sale of aircraft for private use should be limited to nonspinning types. This suggestion was made on the grounds that spinning represented an inherent and inevitable hazard. I happen to be fond of nonspinning aircraft myself, and, if I were making a personal purchase, I would be strongly drawn in that direction. However, I was dismayed, as were most of the audience, by the proposal that the freedom of choice of manufacturers or of other purchasers should be so restricted. If the manufacture of aircraft is ever to be limited to nonspinning types, it should be only after we have had satisfactory demonstration that the nonspinning quality can be combined with all the other features that anyone could reasonably desire. That certainly is not true of two-control aircraft as now offered, since they cannot be sideslipped. As long as the sideslip serves any useful purpose, there certainly should be no regulatory barrier against the building and sale of aircraft with which the maneuver can be executed.

Between the two extremes I have cited—on the one hand, a type of regulation to which everyone would agree and, on the other, a type almost no one would support—there is an enormous range of intermediate cases to which individual judgment must be applied. In every such case a balance must be struck between the beneficial effect that a possible regulation might be expected to have on safety and the sacrifice that would have to be made in other respects. The sacrifice that has to be reckoned with may be in a loss of performance or desirable flying qualities, in an increase of weight or cost of the aircraft, or merely in the additional complication and restriction on the designers' freedom of action that results from every introduction of a new regulation.

Safety Equipment

There are many features that would be admitted to add in some degree to the safety of the aircraft in which they

(*Continued on page 36*)

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Introduction

The pressure of the war has accelerated the change from hydraulic to electrical-mechanical systems for control of various devices and parts of aircraft. This paper discusses the electrical-mechanical systems, since these offer many future possibilities which heretofore have not been achieved. The paper is by no means an attempt to compare hydraulic with electrical-mechanical systems but rather to give briefly some of the problems, possibilities, and advantages of the various electrical-mechanical systems.

Advantages of Electrical-Mechanical Installations

At the beginning of the war there were comparatively few electrical-mechanical installations. However, with the increased amount of engineering time devoted to such designs, more and more installations of this nature were made. Production airplanes were, in many cases, changed over, and new airplanes in nearly all cases used electrical-mechanical systems. Not only did the problem of vulnerability to gunfire bring about this change but the problems of accessibility and serviceability, as well as the ease of initial installations, augmented this program. From the vulnerability point of view the electrical system, having the electrical wires freed from the previously conventional shielding conduit and with the wires separated, offers less area susceptible to gunfire. The rupture of a wire by gunfire usually affects only one circuit, while the rupture of an hydraulic tube often affected an entire system or a major portion of a system. In addition, electrical systems can be powered by a multiplicity of wires going through the airplane by different routes and thus have any one wire able to carry normal loads and use the multiplicity of wires in parallel to carry the overload conditions.

It is possible to design electrical-mechanical systems as complete packaged assemblies containing all of the switching controls, control mechanisms, and relays so that for installation it is only necessary to connect the driven mechanism and the standard electrical connector. Production is facilitated since all adjustments can be made beforehand, and there is no bleeding of oil lines and no need for skilled mechanics having a general knowledge of the overall assembly. The result has been simpler subassemblies, expediting production.

Specialized Engineering Development

The increased demand for electrical-mechanical systems has made it possible for some companies to specialize in the engineering development of such products and to devote more time to engineering, laboratory testing, development, proof testing, and field engineering than would be practical for any individual aircraft manufacturer. The result has been that these companies have been and are accumulating an engineering experience, design technique, and manufacturing ability exceeding that possible with any individual company using these products. These specialized accessory companies, as a result, have been doing engineering and design for the aircraft manufacturers.

Design Standardization

These aircraft accessory manufacturers have found it to their own interest to try to standardize on certain designs. However, in many cases, both the aircraft manufacturer and the accessory specialist have had to deviate from these standards. Our company has standardized on component parts that are put together like mechano parts. This has resulted in a great many variations and possibilities to meet aircraft design conditions without new tooling or special development. However, where possible, these minor variations are also being eliminated. The pressure of the war has created a demand for quick deliveries, and, as a result, many aircraft engineers have been willing to change the airplane design to use something that was already in production, changing the airplane rather than wait for the accessory manufacturer to modify his product. This has had a by-product in that accessories of different airplanes are often completely interchangeable in the field, or at least have interchangeable basic parts.

Accessory Development

An interesting example of the development of an accessory that has been subject to constant study and investigation is a linear actuator that performs the same functions as a hydraulic retracting cylinder. The original unit of this type, built in the summer of 1942, weighed slightly over 5 lbs. and was designed to move a peak operating load of 1,000 lbs. As originally built, it actually could move 1,200 lbs.

With the experience gained from this first unit, a completely new design was evolved before the unit was put into production. As initially produced in quantities, the unit was designed to have a peak operating output of 1,800 lbs. but was actually good for 2,200 lbs. Continuous study of details of the design, careful gear engineering, and improved metallurgy, all coordinated with minor modifications in motor design, resulted in a unit that has a peak output of 3,000 lbs., although the weight is still the same as that of the original unit. With a slight increase in the motor size, the unit has a peak output of 4,000 lbs. axial load. Indicative of how the current requirements have dropped per given load or how the output has increased per given current input is the fact that the original unit had a mechanical efficiency for the gear box and screw of 18 per cent, the production unit 31 per cent, and the most recent design 41 per cent. All of the designs were with a half-depth Acme thread screw. The use of the ball-bearing screw would further increase the overall efficiency and the output.

Accessories such as these are used for operation of cowl flaps, wing flaps, landing gears, tabs, valves, oil cooler shutters, engine cooler shutters, carburetor air-intake shutters, and the like. It is obvious that these are, in nearly all cases, intermittent duty mechanisms.

Weight and Efficiency

In the design of such accessories, an increase in efficiency is usually of value only when it results in a saving of weight, except in the case of extremely large units where current drain is of importance. An increase in efficiency usually means an increase in output, and, unless the unit is highly loaded, offering an increased safety margin,

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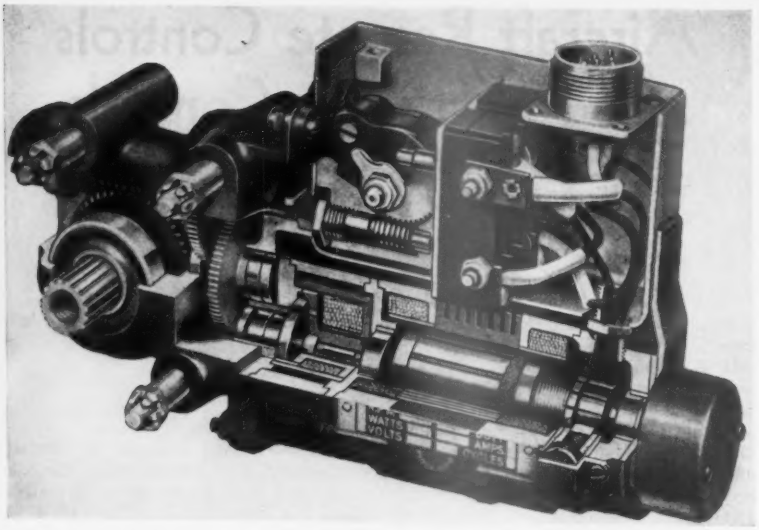
* Vice-President-Chief Engineer.



Lear rotary actuator. The maximum output of this actuatör was 500 in.lbs. With slight modifications and no increase in weight, maximum output was increased to 1,000 in.lbs.

there is often no practical value to the increase in efficiency. However, by continual effort to raise the efficiency, it is usually possible to substitute a smaller, similarly designed unit or to use the originally improved unit in the place of the next larger unit for another application. As an example, on one small pursuit airplane having two linear actuators in the engine temperature control system, one for oil and one for glycol, each weighing 7.29 lbs. complete with automatic temperature control, it has been possible to substitute the next smaller unit weighing only 4.79 lbs. complete with automatic temperature control. In this one airplane a total saving of 5.22 lbs. in the empty weight has been achieved. In another application calling for a rotary actuator for a four-engined airplane, the original requirement was to operate a shutter giving a 200-in.lb. load requirement on the actuator. A unit weighing 4.39 lbs. was designed in 1940 and put into production in 1941. It was satisfactory for the application. By continual tests, by refinement of details without any major changes, and by keeping all subassemblies interchangeable it is possible for the same basic unit to have an output of 500 in.lbs. without an increase in weight. With a smaller motor that fits on the same mounting, the weight can be reduced about $^1/_2$ lb. and still produce 300 in.lbs. With an improved motor of the same size and weight as the original unit and with improved details in gearing, the output goes up to 800 in.lbs. at the same 4.39-lb. weight, or slightly less if magnesium is substituted for aluminum.

At the same time, the aircraft manufacturer made flight tests on the actual installation and reduced the required load to 80 in.lbs. A new unit was designed incorporating the experience of the original unit. The new unit has a normal output of 80 in.lbs. and a maximum of 125 in.lbs. and weighs only 2.10 lbs., a saving of 9.08 in.lbs. in the empty weight of the airplane. The new unit is now going into production.

Designing for Minimum Weight

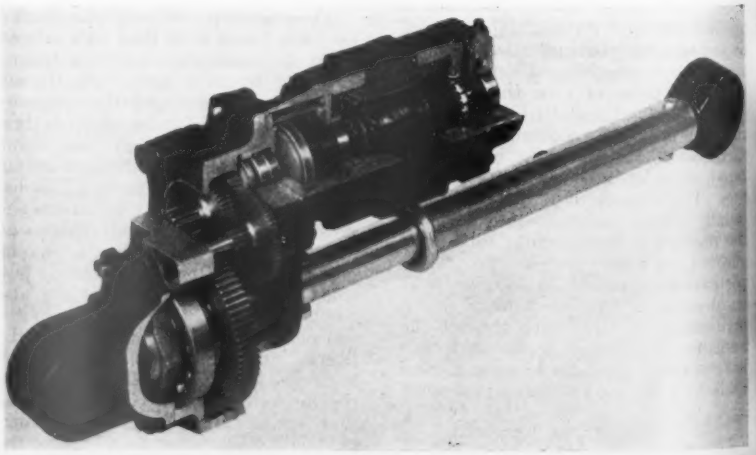
To design accessories for the minimum of weight, it is necessary to work closely with the aircraft designer on the actual loads in the airplane. Obtaining this information in a usable form from the airplane designer has been one of the most difficult problems of the accessory manufacturer. Most aircraft engineers have been accustomed to thinking in terms of static structures and are apt to overlook the fact that the design conditions might be dictated by movement of the mechanism. One valuable way of confirming these loads from flight tests has been to fly the unit under different flight conditions, observing the voltage and at the same time recording automatically the current, accompanying this, if possible, by a recording position indicator. It is possible later to take the unit out of the airplane, apply this same voltage, and load the unit until the current is the same as that observed in flight in order to have a direct indication of the flight loads. Since it is often difficult to calculate the exact loads on cowl flaps, landing gears, tabs, etc., this method has proved to be valuable in checking design figures and for determining loads for future designs.

Loads on Accessories

In discussing loads on accessories, poor terminology has been one of the causes of confusion. Though it is obvious that one should distinguish between load and strength, these terms are often used loosely. Since in nearly all aircraft-operated devices the load varies with the stroke and also with the operating conditions (such as air speed), it is necessary for the accessory manufacturer to have an indication from the aircraft manufacturer of the required loads. The *Normal Operating Load*, best given in the form of a curve of load versus travel, is sometimes given as the average applied load over the operating stroke. The *Maximum Operating Load* is the recommended peak applied load at any point of the operating stroke. The *Emergency Operating Load* is the maximum applied load under which the unit may be operated without failure.

Duty Life Under Load Conditions

It is valuable for the accessory manufacturer to have the expected duty life under each of the load conditions. As the aircraft manufacturer is not usually in a position to determine such requirements, the accessory manufacturer has often determined the operating life for a certain type of application by experience and, thus, designs for this condition. When there is no duty cycle given, our practice has been to design for 30,000 operations under the *Normal Operating Load* and 10,000 operations under the *Maximum Operating Load*. If the unit were to be operated under the *Emergency Operating Load*, its life would



Cutaway of linear actuator, used for wing flaps, coolant shutters, etc. Weight 5$^1/_4$ lbs., peak operating load 2,200 lbs.—load in tension or compression.

The B.F. Goodrich Airline of the month

NORTHWEST AIRLINES

Long known for its fast service between Chicago and Seattle, Northwest Airlines, Inc., has branched out into other important activities since the war began. Currently employing more people than any other domestic airline, Northwest operates two Bomber Modification Centers for the Army. In addition, Northwest personnel were largely responsible for the establishment of the Army-controlled air route from Minneapolis to Alaska.

Many B. F. Goodrich products fly Northwest's routes. De-Icers help keep their planes in year-round operation. Silvertown tires mean smoother take-offs and landings. Expander Tube Brakes give Northwest pilots excellent ground control.

For their excellent record of service in both commercial and war activities we salute Northwest Airlines, Inc.—this month's "Airline of the Month."

"In war or peace

B.F. Goodrich

FIRST IN RUBBER

NEWEST ICE PROTECTION DEVELOPMENT...

the electrically heated propeller shoe

Any pilot who has ever run into icing conditions without propeller ice protection knows why it's so vital to safe flight. Without it, ice forms on the blades, causing loss of propeller thrust, unbalance, and excessive engine vibration. Then, too, there is the danger and annoyance caused by ice flying off in large chunks and hitting the windscreen or fuselage.

It has long been felt that a blade covering which could be heated would be an efficient method of protecting propellers against icing. This type of ice preventer would be particularly well suited for use on long-range military aircraft.

Years ago, B. F. Goodrich engineers began development work on this type of blade covering. Today, the electrically heated propeller shoe is a reality . . . and it has performed amazingly well.

This new ice protection device containing synthetic rubber fits over and is cemented to the propeller blades' leading edges. It covers the area of the leading edge, where icing usually occurs. Electrical current from a generator (which may be mounted on the hub) produces heat in the shoe material. A special construction of the shoe concentrates heat directly at the leading edge, where ice protection is most vital. Efficiency is promoted by electrical and heat insulation at the blade side of the shoe.

The surface of the shoe is smooth, and conforms to the contour of the blade when cemented on. Thus there are no irregularities to upset airflow. Because the shoe keeps ice from forming, maximum thrust is preserved—unbalance and excessive engine vibration are minimized. The shoe also provides a highly abrasion-resistant covering for the blade.

For more facts about this new electrically heated propeller shoe, write to The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.

MAKERS OF B. F. GOODRICH TIRES AND OVER 80 RUBBER AND SYNTHETIC RUBBER PRODUCTS FOR AIRPLANES

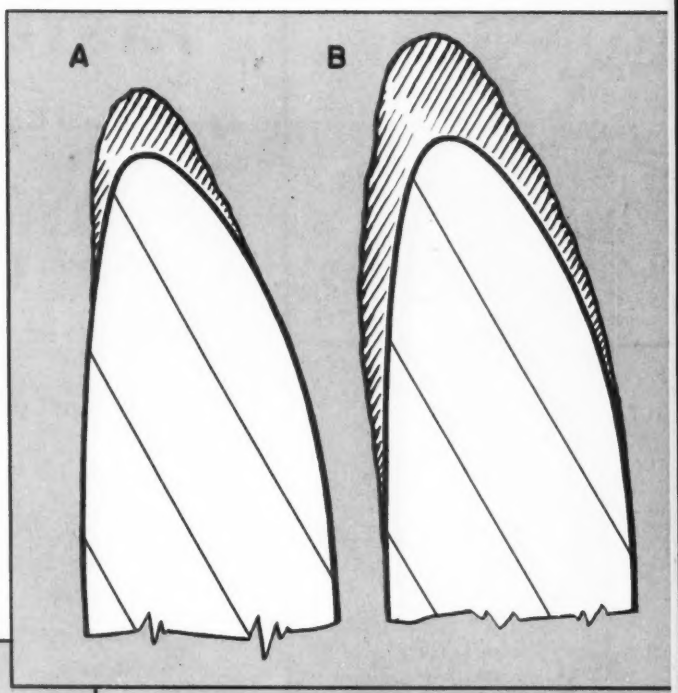
ARMY (E) NAVY

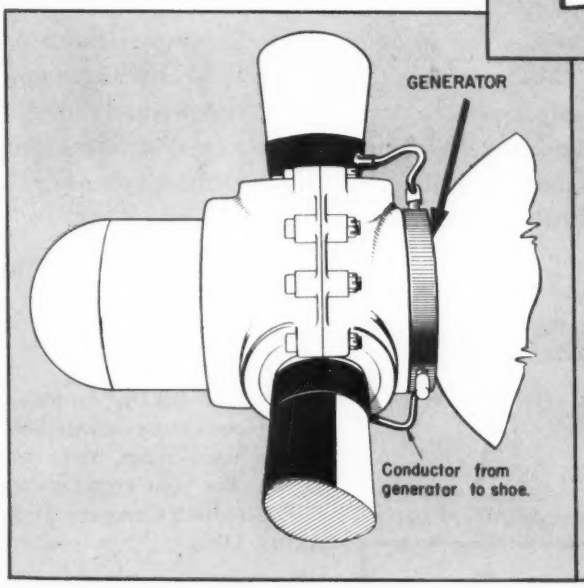
Awards to 9 plants

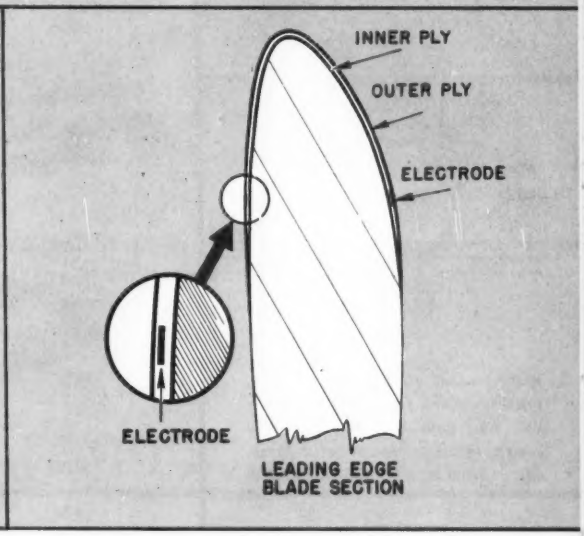
HEAT CONCENTRATION AT PROPELLER LEADING EDGE

increases efficiency at lowest temperatures

Scores of test flights led to the development of a means of concentrating heat across that part of a propeller blade's leading edge, where ice forms under severest flight conditions. In sketch A at right, is shown the way ice often forms under coldest temperatures. Note heavy concentration of ice at extreme edge. Sketch B indicates the greater area covered by ice under warmer conditions. This ice, being softer, melts at lower temperatures.







Simplicity keynotes the operation of the heated propeller shoe, as demonstrated in the sketch above. Note the location of the hub generator, which connects with electrodes in the shoe.

Cross section of a heated propeller shoe (right), showing the heat concentration area and the insulation, which minimizes heat and current loss into the propeller blade.

In war or peace

B.F. Goodrich

FIRST IN RUBBER

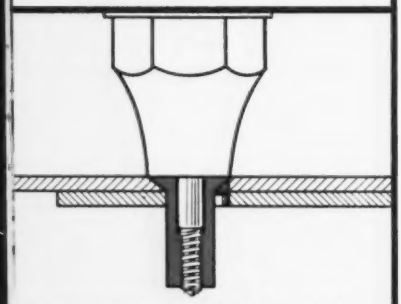
RIVNUTS

ARE IDEAL FASTENERS FOR...

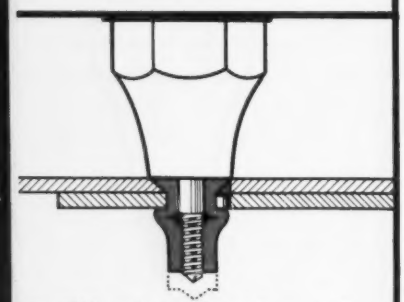
- fillets and fairing
- door and window frames
- access panels
- flooring and upholstery
- wing panel closures
- bonding wires
- clips, brackets, etc., for conduit
- panel board fixtures
- light frames
- plastics

THESE ARE ONLY A FEW of the many uses for B. F. Goodrich Rivnuts in all stages of airplane construction and maintenance. They can be used as blind rivets, as nut plates for attachment, or both . . . they're ready for use as received, without heat treatment or refrigeration . . . they're light, strong, corrosion-resistant. Simple, one-piece construction keeps costs down and makes installation so easy blind men can do it. Get the facts and find out how Rivnuts can help you make better aircraft and aircraft products faster.

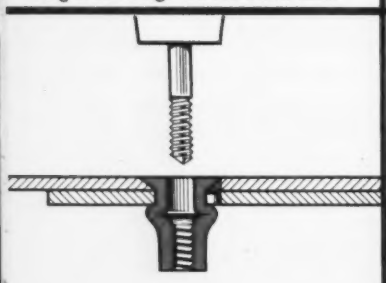
1. *Thread Rivnut onto "pull-up" stud until head of Rivnut touches anvil of heading tool.*



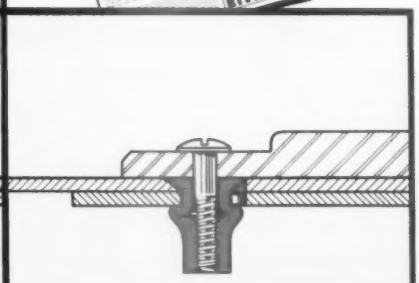
2. *Insert Rivnut into hole. When Rivnut with key is used, be sure the key is indexed to enter the keyway previously cut in metal.*



3. *With tool at right angle to work, squeeze lever. This retracts "pull-up" stud into tool, which causes counterbored portion to bulge, forming a head against the blind side.*



4. *Unscrew "pull-up" stud, leaving threads of Rivnut intact and ready for use as a nut plate.*



5. *Attaching accessory with screw is easy now. Rivnut threads grip screws firmly after upset.*

Just off the press!

NEW FOLDER, "RIVNUT DATA," contains a complete picture story on installation, and Rivnut uses, types, sizes and grip-ranges. For your copy, write to The B. F. Goodrich Company, Dept. 0660, Akron, Ohio.

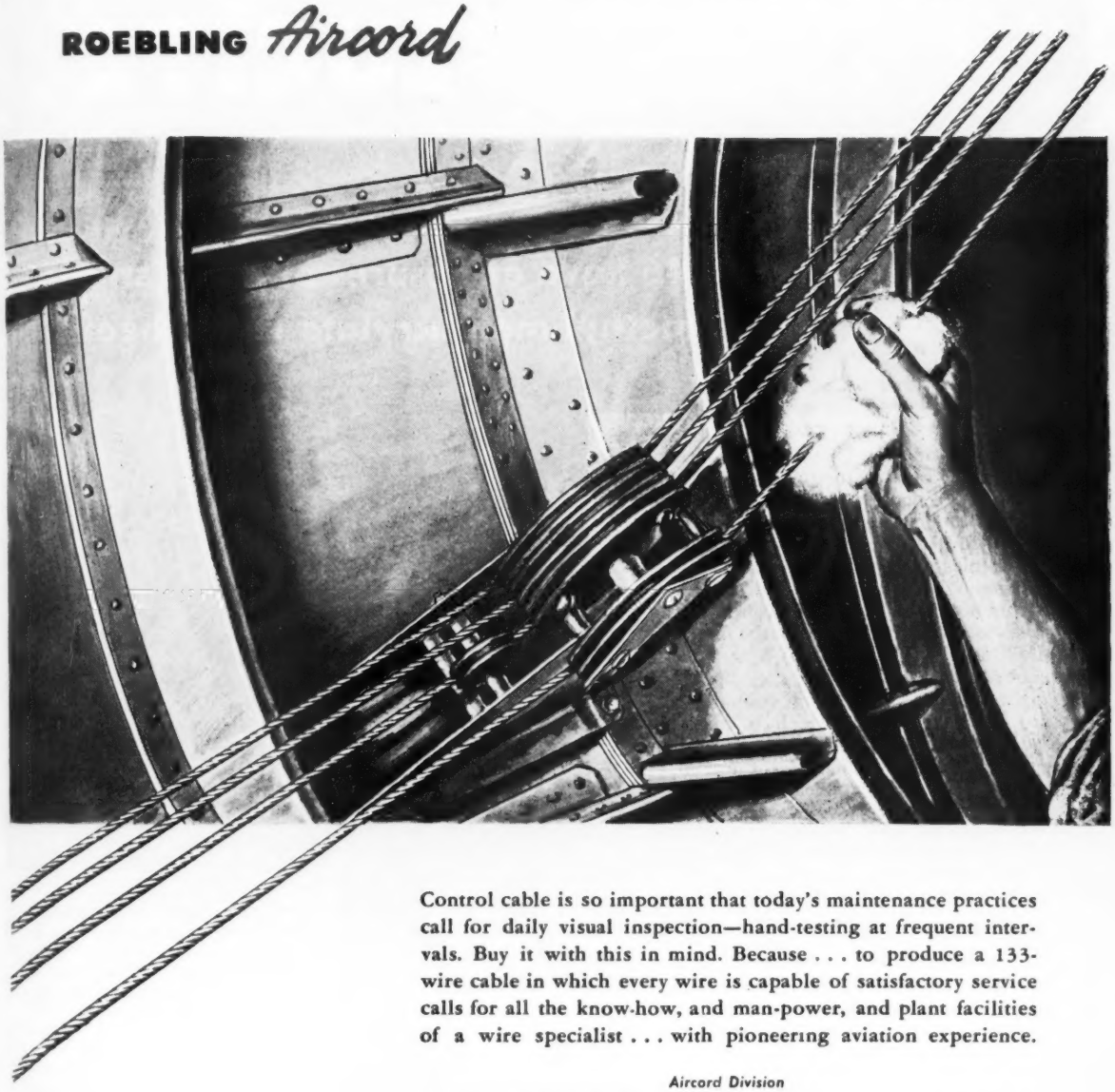
B.F.Goodrich

RIVNUT

IT'S A RIVET...IT'S A NUT PLATE

It's inspected this way . . . and should be bought with this in mind

ROEBLING *Aircord*



Control cable is so important that today's maintenance practices call for daily visual inspection—hand-testing at frequent intervals. Buy it with this in mind. Because . . . to produce a 133-wire cable in which every wire is capable of satisfactory service calls for all the know-how, and man-power, and plant facilities of a wire specialist . . . with pioneering aviation experience.

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The Warhawk, P-40N, latest in the Curtiss-Wright series of great fighters.

HOW CURTISS-WRIGHT USES "LUCITE"

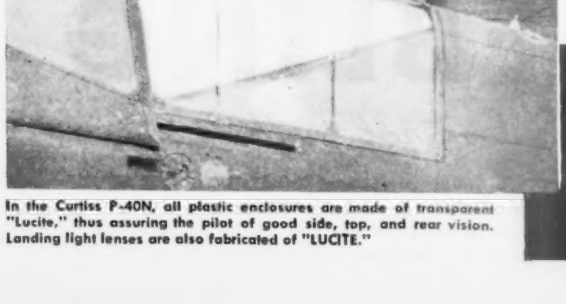
Both P-40N and C-46 have enclosures of clear, strong Du Pont "Lucite" methyl methacrylate resin sheets

IN the P-40N and the C-46, Curtiss-Wright uses Du Pont "Lucite" methyl methacrylate resin sheets for enclosures. Curtiss-Wright's choice is dictated by the same distinct advantages that lead so many other plane builders to use this plastic. First in importance is the *transparency* of "Lucite"; in the colorless sheeting used in aircraft, "Lucite"—even in thicknesses up to several inches—absorbs *less than 1%* of visible light. This feature—plus remarkable sunlight and weather resistance, lightness in weight, tensile and impact strength, resistance to chemicals to which it may be exposed, its ability to be shaped, and other properties—commend "Lucite" for use in a large variety of aircraft applications.

Free Book of Facts on "Lucite." Designers, engineers, and production men will find much useful information in the Manual on "Lucite." This 114-page book gives detailed facts on fabricating, forming, repairing, and general properties. If you'd like a free copy, write on your business letterhead. Address E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Arlington, N. J., or 5801 So. Broadway, Los Angeles 3, California. In Canada: Canadian Industries, Ltd., Box 10, Montreal.

"Lucite" enclosures fit into the streamlined contours of the Commando as snugly as the scales on a fish. Visible here are the four side windows. All use "Lucite"... all are crystal-clear, light, strong, weather-resistant.

Inside looking out . . . co-pilot's seat in the Commando, C-46. Four panels of "Lucite" provide ample side vision from this position.



In the Curtiss P-40N, all plastic enclosures are made of transparent "Lucite," thus assuring the pilot of good side, top, and rear vision. Landing light lenses are also fabricated of "LUCITE."

DU PONT

REG. U.S. PAT. OFF.

DU PONT PLASTICS

BETTER THINGS FOR BETTER LIVING

. . . THROUGH CHEMISTRY

be greatly reduced. We have recently had an application where the aircraft manufacturer asked for only 1,000 operations under a given load curve, which made possible the use of a smaller unit than would have been offered had the aircraft manufacturer not supplied this information.

Maximum Static Load

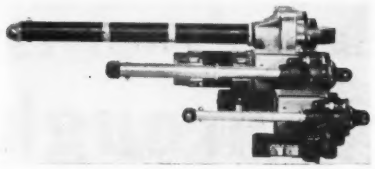
In addition to the operating loads, the accessory manufacturer is interested in knowing the *Maximum Static Load*, which is the maximum nonoperating applied load that will not impair the life, strength, or performance characteristics of the unit. It is sometimes called "limit load, nonoperating conditions."

Unit Strength

The accessory manufacturer rates his units according to the various operating loads and in accordance with the ultimate strength under nonoperating conditions. The *Ultimate Strength* is referred to as the nonoperating applied load in which failure of the unit as a structural member will occur, while the *Yield Strength* is a minimum nonoperating applied load that may cause permanent damage of any nature to the unit. This is sometimes referred to as the "non-Brinell strength."

Inertia Loads

Electrical-mechanical systems have always been confronted with the problem of handling inertia loads. Originally, it was almost impossible to position accurately an electrical-mechanical device because of the variation in coasting and override with varying external flight loads and flight conditions such as temperature, etc. Through the use of an electromagnetic clutch to separate the high inertia parts from the lower inertia parts of the device, accurate positioning has been possible. It is our practice to install a simple magnetic clutch between the motor and the first gear train. Electrically, it is in the motor circuit. Thus, the motor armature, with its high speed and consequent high inertia, can be automatically separated from the driven mechanism whenever the motor circuit is interrupted. By having the clutch located at the motor end of the gear train, the clutch has been a minimum size, since at this point the transmitted torque is low. The gear mechanism, with its consequent lower speed and lower inertia, is stopped by a brake. Two different means of applying this brake are used. Conventionally, the brake is applied by a spring that is overcome by the magnetic force when the motor is energized. In this arrangement, whenever the motor is not energized, the brake is applied, which increases the manual load in devices provided for manual emergency operation. To eliminate this difficulty we have developed a second type, one that has the clutch energized magnetically in the conventional manner to transmit the load under power. But, when the



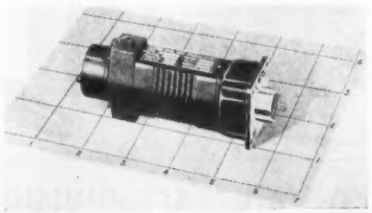
Three sizes of linear actuators. The smallest weighs 3 lbs. and has a maximum output of 500 lbs. axial load; the largest weighs 16 lbs. and has an output of 3,500 lbs. axial load.

circuit is opened, there is an arrangement whereby the spring is replaced by the centrifugal force of the rotating parts and the brake is applied as before, stopping the unit. After this, of course, the centrifugal force disappears and there is no longer any brake drag to retard the manual operation.

Emergency Operation

Since electrical-mechanical systems are essentially mechanical systems with an electrical power source, they offer many possibilities for mechanical emergency operation in case of electrical failure. Various basic arrangements have been designed. The simplest and most direct is to operate the unit manually by hand crank or cable. One unit in production which would require a manual emergency operation in only one direction has a spring-loaded drum around which there is a cable leading to a handle in the cockpit. The handle is pulled by the pilot, turning the drum and operating the mechanism. A pawl holds the driven mechanism at the end of the stroke, while the spring returns the handle to the original position. Thus, the handle can be used repeatedly by the pilot to move the device to the desired position.

Another method of emergency operation is direct hand cranking. This is usually done by the use of flexible shafting which turns at high speed and low torque and is often used in the system to serve another purpose at the same time, as will be discussed below. Another arrangement for emergency operation is to have two or more power units interconnected mechanically, such as the two main-wheel actuators and the nose-wheel actuator, with each having its own individual power unit. Thus, while one or two motors may be inoperative, the remaining unit will operate the entire system through mechanical interconnection. A landing-gear system of this type is in production. The landing gear can be raised or lowered by any one of the three motors or directly by a hand crank in the mechanical interlock portion of the system.



Typical high-output, small-size motor; .04-hp. normal rating, .05 maximum.

For some applications such as landing gears, the most desirable emergency operation might be to release the unit and let gravity provide the necessary force. It is possible that in some applications the energy of dropping the landing gear to the lowered position might be sufficient to require an appreciable shock-absorbing mechanism to absorb the forces produced by the high inertia of the dropping gear. A lock holds it in the down position.

Control

Limit Switches

The control of the electrical-mechanical devices varies with the requirements. The most simple is by the use of limit switches, which are normally incorporated in part of the gear mechanism. It has been found best to locate these as part of the motor and gear mechanism assembly. The possibility of errors because of improper coordination between the switch adjustment and the driven mechanism is eliminated by having these switches adjusted in a jig at the accessory factory or on the bench before installation. With this system the unit may be stopped at any intermediate position. Sometimes an electrical position indicator is used.

In some installations it is not possible to predetermine precisely the required travel of the driven device so that it is not possible to use limit switches. To achieve the desired result, it is practical to have the unit run against a stop or shock absorber and then have the power shut off because of some overload device. These are of two types. On one the current overload due to the higher current to the motor actuates a relay. The other is the mechanical overload type where a mechanical torque limiting device moves, or a load-actuated spring device moves, actuating a cutoff switch.

Remote Preset Devices

Another type of control practical for certain applications is a remote preset device having a mechanical follow-up. In such a system the control in the cockpit operates switches which control the actuation of the device. When the device is actuated it also moves a flexible shaft or mechanical follow-up leading to the cockpit, moving a position indicator and also the commutator or electrical contact that opens the circuit when the desired position is reached. In some of the devices of this nature it has been possible, in an emergency, to operate a driven mechanism through flexible shafting from the position indicating control in the cockpit. This has been practical for tab controls and similar lightly loaded units. On large airplanes with long flexible shafting it is not so practical as other means for tab controls.

(*Continued on page 141*)

Air Power Through Piston Rings

McQUAY-NORRIS
ALTINIZED
PISTON RINGS

PISTONS . . . PINS . . .
HARDENED AND GROUND PARTS

More and more, the leading makers of aircraft motors are using McQuay-Norris precision parts. Our 34 years' experience in precision manufacture, our long and intensive work in metallurgy, heat treating, clinical research and laboratory experiment, enable us to turn out the sturdy, dependable parts demanded by modern aviation. Your inquiries are invited.

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Oil Sealing Rings
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Machined Aluminum Pistons
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Machined Magnesium Parts
Cylinder Hold Down Nuts
Hardened and Ground Parts

PARTS FOR PROPELLER ASSEMBLY

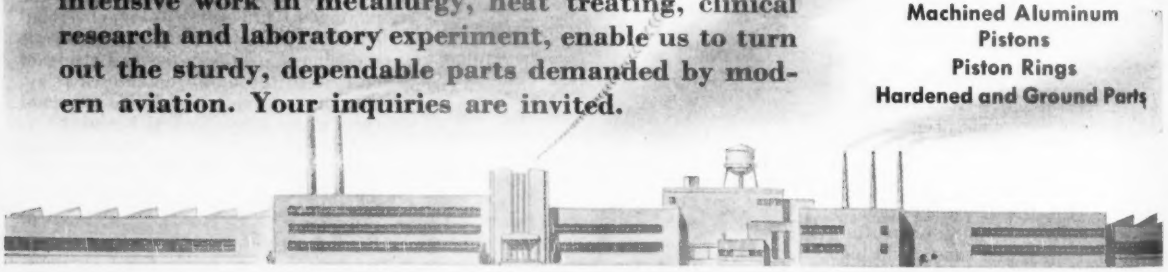
Machined Magnesium Parts
Piston Rings

EQUIPMENT FOR MAINTENANCE OF AIRCRAFT

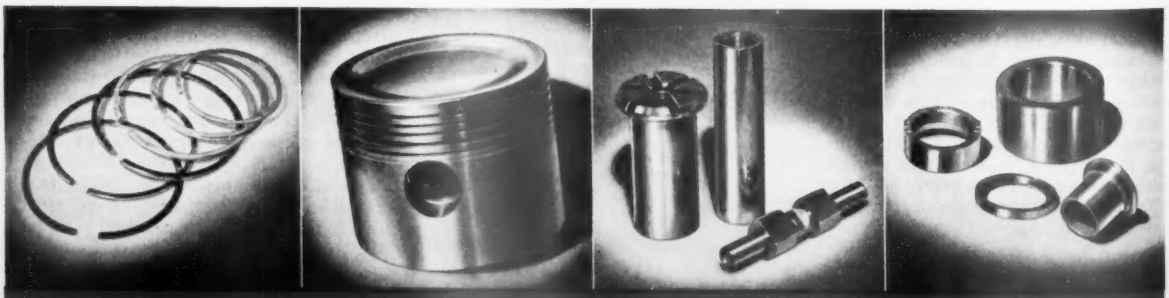
Pistons for Oxygen Compressor
Piston Rings for Oxygen Compressor
Pins for Oxygen Compressor
Pistons for Air Compressor
Pins for Air Compressor
Piston Rings for Air Compressor

LANDING GEAR PARTS

Machined Aluminum Pistons
Piston Rings
Hardened and Ground Parts



PRECISION WORKERS IN IRON, STEEL, ALUMINUM, BRONZE, MAGNESIUM



McQUAY-NORRIS MFG. CO. (AIRCRAFT DIVISION), ST. LOUIS, U. S. A.
CANADIAN PLANT, TORONTO, ONTARIO

Resin Adhesives for Aircraft

THOMAS D. PERRY* and HENRY GRINSFELDER†

The Resinous Products & Chemical Co., Inc.

Introduction

Resin adhesives have become commercially important in the United States during the last decade. Their successful use has been responsible for fundamental changes in the technique of manufacturing plywood as well as in many other problems of wood adhesion. It is indisputable that synthetic resin adhesives have brought about the greatest advances that have occurred in the plywood industry during the last quarter of a century.

The earliest known glue was animal glue made from the bones and hides that eventually became important by-products of the meat-packing industry. This traditional experience, gained with various successive types of animal glues, has been so fundamental that all of the later adhesive developments have been evaluated on a basis of the characteristics of animal glue. Other conventional glues that followed the animal glues were vegetable (cassava flour), silicate of soda, casein, blood albumin, etc., developed progressively since about 1900. There were several rather serious limitations in most of these older glues, among which two of the major handicaps were their lack of endurance under exposure to severe weather and moisture conditions and the length of time required under pressure to secure a durable bond.

During World War I casein and albumin glue were credited with being the most durable conventional glues available for primitive aircraft of that era. Casein had a considerable degree of moisture resistance, since the lime content produced a hardening action much as in cement. Blood albumin, another packing-house by-product, was the first instance of successful hardening under heat. This was accomplished by coagulation of the albumin, which is irreversible under subsequent exposure to moisture. The equipment required for the heat hardening of blood albumin was the first step toward shortening the clamping period from hours to minutes. The presence of such hot presses was a definite aid in the later development of a similar technique for resin adhesives. Both casein and blood albumin were found to be an inadequate answer to the problem of suitable adhesive for plywood in the growing aircraft industry, since they both seriously deteriorated with age.

Development of Resin Adhesives

Early Experiments

The promising qualities of synthetic resin adhesives had been noted in the 1920's and considerable development took place in Europe during that decade. However, there was little available equipment in American industrial plants to employ heat in curing plywood bonds, and the cost of these early resins was considered prohibitive. The earliest practical use of resin adhesives in this country was in the early 1930's, when Tego film was imported from Europe and used to a limited extent on the hot presses that had been installed for the blood albumin developments of the preceding decade. It was not until 1935 that resin adhesives became commercially available from domestic sources. In this year Tego film was made available to American manufacturers at a substantially lower cost than that of the imported film.

Nearly ten years have passed since this initial introduction and it may be considered an appropriate time to review and evaluate the growing family of resin adhesives in the light of this decade of experience among American manufacturers of plywood.

Such a review, to include no more than the important aspects of the subject, must be relatively brief and general in character. There have come to be a number of reputable and responsible manufacturers of synthetic resin adhesives whose products may differ in certain particulars. Hence, no exact formulas or definite schedules can be included, but approximate data are given with the expectation that readers will consult their suppliers for more detailed information.

Influence of Heat in Completing Bonds

One of the important factors in establishing the success of the synthetic resin industry was the shortening of clamping time required for a satisfactory setting of the adhesive from a matter of hours to a few minutes. While this was not immediately appreciated by the industry, it has proved to be one of the major reasons for the success of the new adhesive program. The heat was originally applied to plywood by means of steam-heated platens. A series of pairs of these platens were arranged in a hydraulic

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* Development Engineer.

† Senior Chemist.

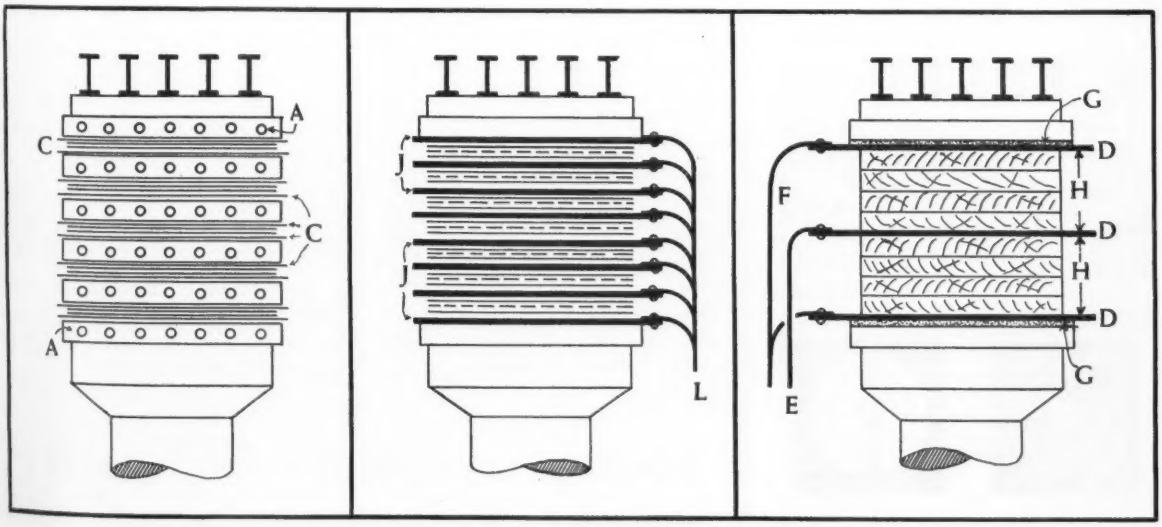
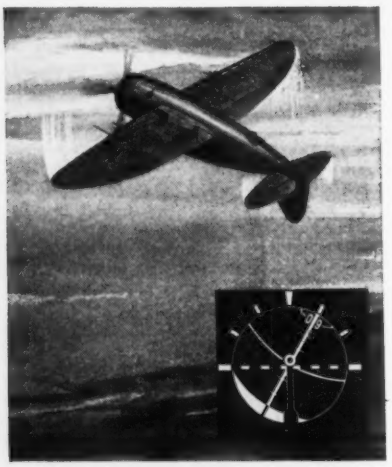


Fig. 1. Methods of applying heat to plywood. *Left:* Steam-heated platens. *Center:* Cauls with resistance units incorporated. *Right:* Radio Frequency heat, sandwich type.

Pattern indication gives the pilot a visual "picture" of his attitude at all times, regardless of the degree of bank, climb, or dive.



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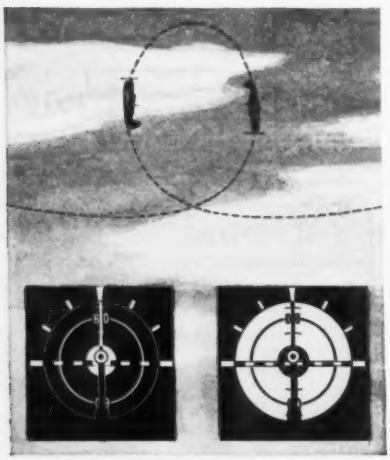

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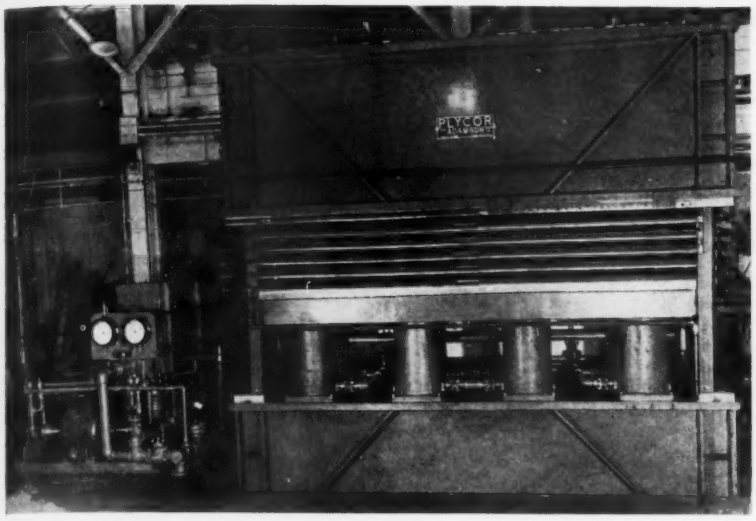

Courtesy Plycor Company

FIG. 2. Largest hot press in service. Installed at Roddis Lumber & Veneer Company, Marshfield, Wisconsin. Five openings, 198 by 62 in., steam-heated platens.

press and the layers of plywood were inserted between the pairs of platens. The early presses were imported, but it was not long before presses were available from domestic sources, since they did not differ in any important respects from presses used in this country for sheet rubber and laminated plastics.

A few attempts were made to use interleaved metal sheets in which resistance heating units were incorporated but, aside from one or two important plants, this method of applying heat did not attract much attention. Within the last 2 or 3 years radio-frequency heating equipment has been developed to apply heat to the cure of resin adhesives. It has several features that were not found in either the steam-heated platens or the resistance heating units. The most useful adhesive application of radio-frequency heat is its ability to heat thick wood assemblies through and through with a reasonable degree of uniformity in the entire assembly and within a surprisingly short interval of time. These radio-frequency heating units are based on the same principle as the diathermy apparatus that has been employed for many years by the medical fraternity to heat human tissue without burning the skin. A graphic comparison of these three methods is shown in Fig. 1 and a large hot-press is shown in Fig. 2.

Importance of Waterproof Adhesives

The speed of bond completion with heat is not the only valuable attribute of resin adhesives. The process of heating a resin produces an irreversible chemical and physical change, which was first recognized in blood albumin glue during the time of World War I.

The older animal and vegetable glues hardened by means of the evaporation of the solvent and they were more or less resoluble when exposed to water. In other words, theoretically at least, this type of water-soluble glue could be reclaimed, redissolved, and used over again. Casein was somewhat of an exception to this rule and blood albumin set under heat was not resoluble. In the case of the synthetic resin adhesives the chemical and physical changes produced by heat render them distinctly nonresoluble under exposure to moisture.

This quality of durability in the presence of moisture became a second important contribution made by the synthetic resin adhesives to the plywood and wood-using industries. Resin adhesives, when properly chosen, efficiently applied, and cured under heat, will produce a bond that is more durable than the wood layers thus joined together. This was an important adhesive development and was found to be of substantial help in the plywood requirements of World War II.

Resistance to Mold and Fungi Growths

In addition to the waterproofness of the resin adhesives, experience demonstrated that practically all of these types of resin adhesives are strongly resistant to mold and fungi growths. The resin adhesives themselves will not support mold or fungi growths and effectively inoculate the wood for a considerable distance from the glue joints. These parasitic developments had always been found troublesome with the older conventional glues when plywood was exposed in warm, humid climates, such as the tropics, and even casein and blood albumin were seriously weakened under such conditions.

Heat Resistance of Phenolic Adhesives

Still further, it appeared that the phenolic resin adhesives are not adversely affected by heat up to a temperature that will deteriorate the wood. This, however, is not true of other classes of resin adhesives, such as the ureas.

However, the fact remains that phenolic resins cured under heat are found more durable in every way than any previously known wood adhesive. Urea resin adhesives approach the phenolics in durability and are definitely superior to all of the earlier conventional glues.

Thermosetting vs. Thermoplastic Technique

An adhesive is said to be thermosetting when it first softens under heat and then cures or hardens irreversibly under continued heat. Thermosetting resin bonds can be removed from pressure while still hot without sacrifice to the bond strength. This is a substantial advantage in production and is an important element in the conservation of equipment time.

On the other hand, thermoplastic adhesives are somewhat like metals—they become liquid and flow when heated, they harden when cooled, and the cycle can be continued indefinitely. Thermoplastic adhesives have been developed for woodwork but, because of this peculiar quality of resoftening under heat, they require that pressure be maintained until the glued assembly has been cooled below the temperature of thermoplastic flow. This is a serious handicap in production and has prevented the widespread use of thermoplastic adhesives in woodworking operations, since the cooling of any substantial wood assembly is a time-consuming operation. Thermoplastic adhesives, however, have a definite place in development and experimental work, where time is not important, because it is possible to rework various assembly constructions toward the eventual desired goal. There are also certain minor advantages in the toughness of a thermoplastic joint, since this type of resin does not become so hard as do the thermosetting types. From a commercial standpoint thermoplastic resins do not appear to be destined to become important in woodworking operations of substantial magnitude.

Classification of Resin Adhesives

There are two major classifications of synthetic resin adhesives—the phenolics and the ureas.

Phenol-formaldehyde resin adhesives are the most durable type of synthetic resins for woodwork. They are thermosetting and possess durability superior to that resulting from any of the other resin adhesives. Phenol-formaldehyde resin adhesives are available in film, powder, and liquid form. The films and powder have better storage life than the liquid type. From the standpoint of present knowledge, substantial heat seems essential to obtain a satisfactory cure with the phenol-formaldehyde types. However, studies now in progress would indicate that these temperatures can be considerably modified without appreciable sacrifice of durability, and it seems reasonable

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to expect that moderate-temperature phenolics, between 175° and 225°F., may soon become commercially important and possibly supersede the higher temperature types in certain applications.

The other important class of synthetic resin adhesives is that of the urea-formaldehyde type, which is also thermosetting and is available in powder and liquid form but not in film form. The ureas, in general, require lower temperatures than the phenolics and, with certain catalysts, can be satisfactorily cured at room temperature of approximately 75°F. The urea resin adhesives differ from the phenolics in their adaptability to the addition of high ratios of low-cost extenders, such as wheat flours, while still possessing substantial water resistance. The urea resins are not so durable under moisture and heat exposure as are the phenolics, but their durability characteristics are much better than those of the other conventional glues. This compatability with extenders makes it possible to secure urea resin bonds in cost ranges that approach those of the early glues but with far better durability.

The cure of urea resin adhesives is usually facilitated by catalysts, commonly acidic in character. There is a considerable range of appropriate formulas, as well as of adjustments in required temperatures and in clamping periods.

Urea resins are also available in fortified form. This requires the addition of chemical ingredients with the catalyst which increase the durability of the urea bond so that it more nearly approaches the durability of phenolics.

There are several other types of resin adhesives, less important at the moment, which are just emerging from the development stage and may become commercially available in the future. At the present time, however, there seem to be serious limitations of cost which may prevent their economic comparison with the ureas and the phenolics. In the main, these lesser known resins, such as melamine and resorcinol, are used in combination with the ureas and the phenolics, since this affords their advantages while maintaining the cost factors within moderate limits. Whether these resins will be used by themselves remains for the future to determine. The melamine resins are chemically similar to the ureas, while the resorcinol is a particular type of phenol.

All of the above resins are of the thermosetting class. The thermoplastic resins are usually of the polyvinyl butyral type and have interesting possibilities, although their limitations have been noted above.

Correlation of Testing Procedures

Most of the testing procedures for these synthetic resin adhesives are on a performance basis. They have been developed under the stress of military requirements for Government projects and, hence, are distinctly of the accelerated type. So far as is known, the correlation of these accelerated tests with actual service experience has not been adequately studied. It is well established that boiling tests, wet and dry cycle tests, and weatherometer tests may be used to evaluate the relative quality and comparative durability of any particular resin adhesive, but it is not at all certain that these accelerated tests, as a whole, are representative of what really happens to the plywood bond under actual severe service. This is a phase of investigation that should have far more attention than has so far been accorded it by students and research laboratories.

Application of Resin Adhesives

Primary and Secondary Adhesives

The distinction between primary and secondary adhesives is not one of the type of glue but rather of its method of utilization. A primary adhesive is one that is used over large areas, such as any glue used for the manufacture of plywood, before the plywood is joined to other wood or plywood parts with a secondary adhesive. Since the primary adhesive is used in substantial quantities, its cost factors are important and its processing should be relatively simple to expedite its application in the production of many thousands of square feet of plywood.

A secondary adhesive, on the other hand, is one that is used to glue plywood or wood members together and is often called an assembly adhesive. The quantities used are far less and the cost factors are not so important as in the use of primary adhesives. Secondary adhesives are more dependent on the personal equation than are primary adhesives and, hence, the importance of experience and skilled workmen in their application cannot be overestimated.

Surface Gluing

This is the primary gluing operation required in making flat plywood. Mechanical mixers, spreaders, and hot platen presses are employed. The technique of these operations has been well systematized and, under adequate supervision, the operations can be carried on successfully with a relatively untrained crew. Cleanliness and accuracy are important, but individual knowledge of wood characteristics and adhesive phenomenon are not so important as in the use of secondary adhesives for assembly work.

Form Gluing

This type of gluing is also primary in nature and closely resembles the manufacture of flat plywood except that a moderate amount of forming can be done by using heated metal dies in the hot press which produce depressions or projections in the plywood area. Among these are included the well-known "Toastmaster" trays, barrel staves, formed propeller blanks, and embossed intaglio designs that are similar to hand or machine carvings. Such formed intaglio work bears the same relation to knife carving as do pressed glass designs to genuine cut-glass effects. In all of these formed plywood operations the veneer preparation, the adhesive requirements, and the pressing operations are similar to those employed in making flat plywood.

Molded Plywood

Molded plywood is a different type of plywood construction, midway between primary and secondary gluing,

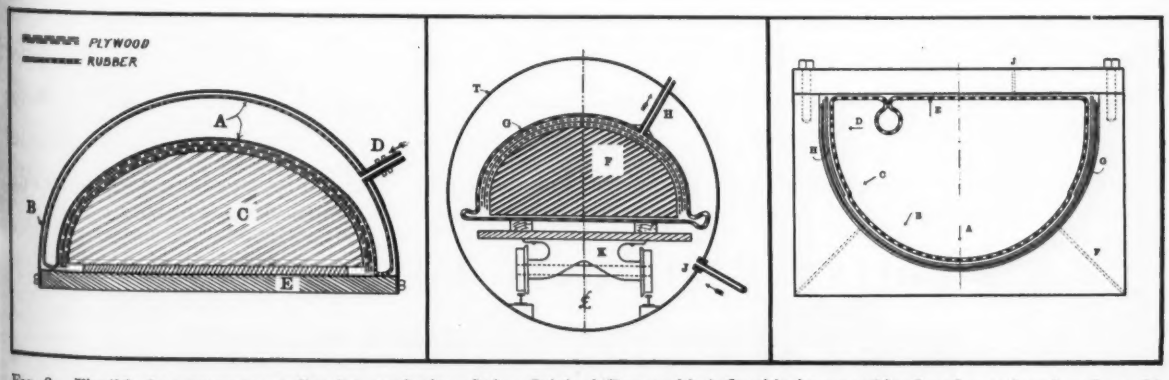
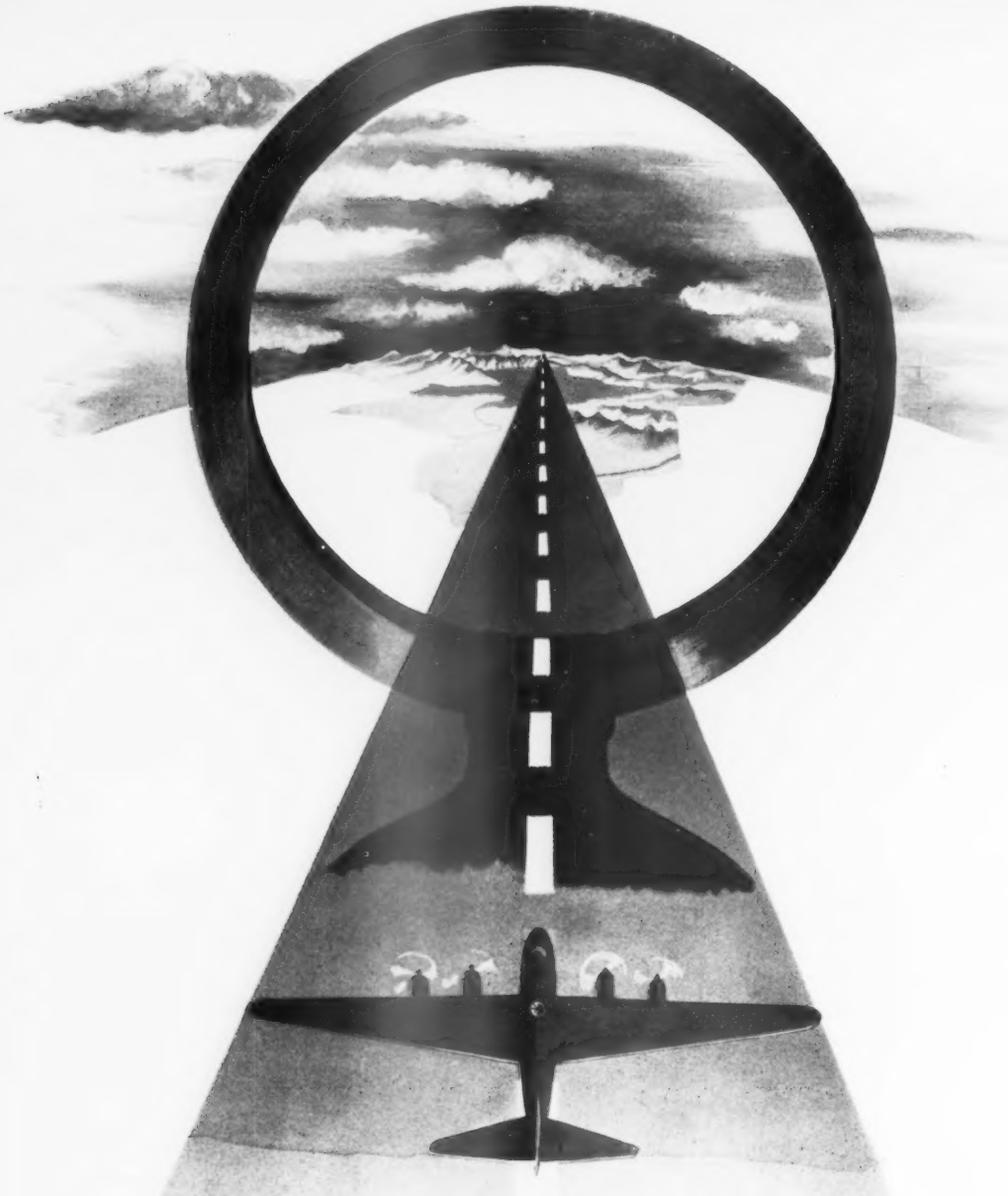


Fig. 3. Flexible bag pressure application methods. *Left:* Original Duramold, inflatable bag outside the plywood and male mold. *Center:* Original Vidal, male mold and plywood inside the deflatable bag. *Right:* Female mold with inflatable bag inside plywood.



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since the layers of veneer are built up or assembled on convex or concave molds. When products have only simple curvature, like cylinders, the veneer may be used in sheets, as in the making of flat plywood. In the case of compound curvature, such as sphere or egg-shell shapes, often called monocoque, the veneer must be cut into irregular or tapered strips so as to fit snugly together and to conform to the shape of the mold or matrix. The pressure in this molded plywood is usually of the flexible bag type, exerted by inflating or deflating a rubber bag with steam or hot water. This may be done either within a closed mold or by means of an external autoclave or cooker (see Figs. 3 and 4). There are a number of patents in this field, and interested parties should investigate carefully.

Paper, Cloth, and Fiber Combinations

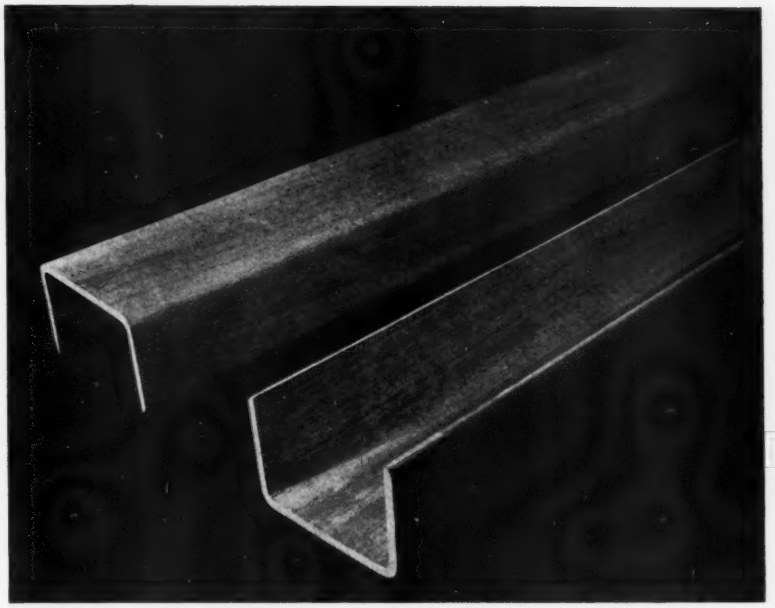
There are extensive developments in progress which utilize layers of veneer, paper, cloth, and fiber in various combinations. These are becoming increasingly important, since each of these types of material can contribute special qualities that may be essential in certain products. Considerable quantities of flat plywood are now made with paper exteriors and both cloth and fiber are extensively used in formed and molded constructions, either with or without layers of veneer. It should be noted that the use of paper, cloth, and fiber combinations results in much higher resin contents than is the case with veneer alone. Hence, the strength and physical characteristics are more those of the resins than of the materials glued together.

Impregnation

It is obvious that the use of resin adhesives with thin veneers will produce a partial impregnation into the wood surfaces of all layers. Since the durability of resin adhesives is normally greater than that of the wood, the use of this impregnation technique is often employed to improve the durability of the wood. The amount of impregnation under this process can be controlled both by the amount of resin applied and by the thinness of the veneer.

In other cases, synthetic resins similar to the adhesives but of smaller molecular size are especially prepared to permit a more complete impregnation than can be obtained by the use of resin adhesives alone. These special impregnating resins, in liquid form, are forced into the voids of the wood by alternating cycles of pressure and vacuum or by pressure alone. Under this process, these resins penetrate both the cell cavities and the spongy cell walls and may result in products with higher impregnation ratios and improved dimensional stability under soaking tests. This dimensional stability is usually accompanied by relatively low resistance to impact.

Developments are not sufficiently advanced to determine the relative commercial costs of these two methods of securing impregnation, but they both hold promise of wide utility. However, resin impregnation is rapidly developing into a separate industry and bids fair to supply many industrial requirements for more durable and stronger types of laminated wood and plywood constructions.



Courtesy Molded Wood Products Company

FIG. 4. Plywood channels, or "U" bars. Employed for ends and edges of CG-4 glider floors. Opening, 6 in.; length, 14 ft.; bag molded in 15 plies.

Assembly Gluing

Assembly operations in wood products are a secondary type of adhesive use, and there are many useful applications in which resin adhesives can be employed. These will vary from the relatively simple operation of gluing small plywood gussets to airplane ribs to the more complicated attachment of skin covering to the enormous wings of Army glider planes. While many of these assembly operations are done with urea resins that cure at room temperatures or under slight heat, there is a growing tendency to prefer moderate-temperature phenolics for their greater durability. Such phenolic adhesives require heat for their cure, and both resistance strip heaters and high-frequency equipment are found useful in such work. An example is shown in Fig. 5.

In these assembly operations, special emphasis should be placed on individual experience and skill in the proper application of the adhesive and in the best methods of putting the parts together and clamping them.

It is particularly important that all assembled parts fit snugly before glue is applied. Thick glue lines are a detriment and no glue or adhesive is an efficient gap filler. It is also true that excess pressure used to overcome poor fitting will inevitably cause internal stresses that weaken the joint.

PHENOL-FORMALDEHYDE RESIN ADHESIVE

Characteristics

It has been pointed out that phenol-formaldehyde resin adhesives are the most durable type of resin adhesives developed. Joints made in assembly or plywood operations with phenolic adhesives can be subjected to immersion in boiling water, to multicycle wet and dry tests, to soaking in salt water, and to long-time weather exposure. In all cases, the phenolic bonds have proved to be more durable than the wood itself.

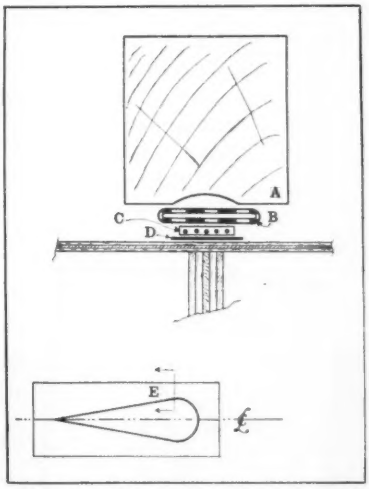
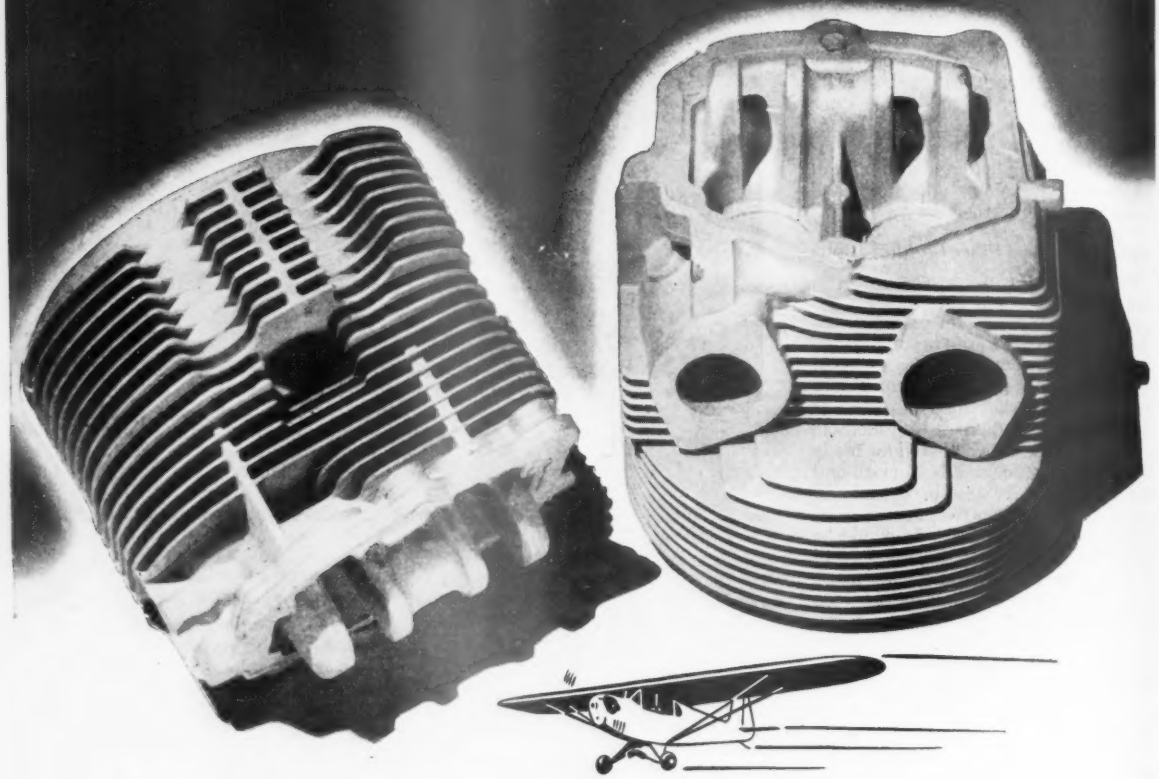


FIG. 5. Tubular pressure and assembly gluing. *A:* Upper half of two-piece clamp. *B:* Deflated hose. *C:* Strip heater, resistance type. *D:* Metal strip to equalize pressure. *E:* Smaller cross section of complete two-piece clamp.

They've helped a lot of Gophers* learn to fly



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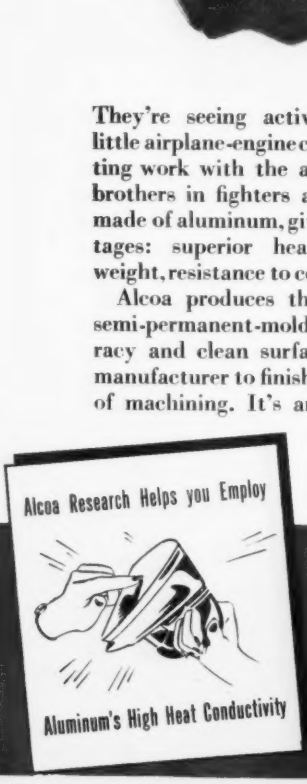

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Natural phenol is a coal tar distillate, while synthetic phenol is derived from benzol, also a coal tar derivative. Both types are used interchangeably in the manufacture of resin adhesives. When combined in various proportions with formaldehyde, they are condensed and polymerized to a predetermined intermediate point in order to simplify the completion of the adhesive bond.

They may be mixed with water or alcohol or a combination of the two and are easily spread on wood surfaces. They tend to flow rather freely as the moisture content of the wood increases and, hence, are best used on relatively dry wood. Most phenol-formaldehyde resin adhesives are supplied in dry form, either as a film (on a paper carrier) or as a powder, and in such forms have excellent storage stability. The Tego film is available in wide rolls for large plywood areas and also in narrow strips, called Tego tape, for repairing breaks and reinforcing ends and edges of thin, fragile sheets of veneer. Liquid dispersions are also available but have rather limited storage life.

Operational Technique

In preparing any powdered or liquid resin adhesive, it is important to follow a definite formula, to weigh or measure the ingredients precisely, and to mix them thoroughly. Mixtures of most phenolic resin adhesives have a working life of 8 hours and up. Catalysts are sometimes used, although most phenolic adhesives are used straight. Equipment should be kept scrupulously clean, and spreading should be done by means of grooved or corrugated rubber rollers. It is important to keep all phenolic spreads at a minimum, since excess adhesive of this type is not only costly but is a definite detriment to the strength or serviceability of the bond.

A spread of 25 to 30 lbs. per 1,000 sq. ft. of glue joint is usually sufficient, but more generous spreads may be found desirable on low-density species or rough cut veneer. Double spreading on both of the two mating surfaces is desirable to secure equal penetration in both directions. In such cases approximately half of the above amounts are spread on each surface. In some constructions single spreading, i.e., on either of the two mating surfaces, will be found sufficient.

In order to counteract the free-flowing qualities of phenolic resin adhesives, it is often desirable to use such extenders as walnut-shell flour up to 25 parts of extender to 100 parts of dry resin. This has a "bodifying" effect that helps to regulate the spread and to control the excess flow.

In the use of most phenolic resin adhesives it is necessary to permit the solvent to evaporate after spreading and before pressing, which usually requires a minimum of from 1 to 2 hours. If the pressing is done before the solvent is evaporated, excessive flow may be found to present serious difficulties. The maximum open assembly time can be a week; in some instances good bonds have been secured after a month. However, more uniform results will be obtained if the assembly is completed within a day or two after spreading.

The use of the Tego film is much simpler, since the rolls are dimensioned into sheets and interleaved between the veneer layers. The moisture content of the veneer should be uniform and sufficient (eight to twelve per cent) to aid in the initial flow of the resin under heat. Veneers thinner than $^1/_{30}$ in. are difficult to spread and the use of a film adhesive is almost mandatory. In veneer thicknesses between $^1/_{30}$ and $^1/_{12}$ in., either liquid or film can be used, with the simpler process favoring the film. For thicknesses of $^1/_8$ in. and up, the liquid application is in wider use, although the film is entirely practical.

The temperature, time, and pressure requirements will depend on the type of resin used and the species of wood to which it is applied. Data on this point should be secured from each supplier for every type of resin. Phenolics are supplied in two temperature ranges—i.e., normal, from 250° to 300°F. with a minimum time of about 8 min.; moderate, from 175° to 225°F. with a minimum time of 20 to 30 min. In either case the time-temperature factor will depend on the heat-penetrating characteristics and volume of the wood between the heat source and the deepest glue line. Pressures will depend on the species of wood but, in general, should be enough to give a slight compression in order to overcome any inequalities of thickness that are inevitable in the use of veneer layers.

While a resin bond is approximately completed on its removal from the hot press, the wood is overdry and the introduction of surface moisture is usually found advisable. This can be done by spraying or dipping or by storage in properly controlled humidity rooms. It should be noted that spraying or dipping should be done while the plywood is *hot* (immediately after hot pressing), since such moistening of *warm* plywood (an hour or two after removal from the hot press) will tend to produce mildew and discoloration on the surfaces of the wood away from the glue line.

Testing Procedure

A number of tests have been indicated in Government specifications for the determination of the durability and strength of phenolic resin bonds. In general, these are based on certain species of wood and in certain constructions that are considered standard. Immersion in boiling water for stated periods is a frequent test for phenolic resin adhesives because it has a definite relation to durability, although this relation has not been fully evaluated. Wet and dry cycle tests and boiling and dry cycle tests are both employed. Ultimate strength tests should not be made on any resin-bonded plywood until it has been aged for at least 6 days.

Determination of Bonding Schedule

Predetermined bonding schedules are available for commercial types of phenol-formaldehyde type resin adhesives and can be obtained from the suppliers. It is always desirable, however, to make a careful factory check of such schedules to determine their suitability to the construction in which they are to be used. Formulas can be provided for the determination of these bonding schedules but, in general, the user is advised to rely on standard schedules that are prepared by the supplier. It is a conservative rule that slightly longer times, somewhat higher pressures, and liberal temperature allowances are safety factors that should usually be employed, even though these are allowed for in many of the schedules.

Urea-Formaldehyde Resin Adhesives

Characteristics

The urea-formaldehyde resin adhesives, although derived from an entirely different type of material, possess working characteristics similar to those of the phenolics. While theoretically they could be used without extenders and without catalysts, the bulk of their utilization is in combination with various supplementary ingredients. Their mixing and spreading is similar to that of the phenolic adhesives, but their flow characteristics are less critical. Urea resin adhesives are available in dry powders and liquid dispersions but not in film form.

In general, the durability of the standard (unfortified) urea type of adhesive bond is rather less than that of the phenolic type, but it is far superior to that of the older conventional glues, even to that of casein. Fortified ureas with special reinforcing ingredients rank in durability somewhere between the standard ureas and the phenolics. It should be noted, however, that the durability characteristics of ureas are reduced by the incorporation of substantial amounts of extenders.

Influence of Extenders

Extenders in substantial amounts can be used in standard urea resin mixtures to reduce the cost of the bond and still maintain a highly satisfactory degree of moisture resistance. In extreme cases these extenders may be in the proportion of one part of dry resin to three parts of wheat flour, thus producing a low-cost bond of definite water resistance. The amount of extenders used, however, should be carefully regulated according to the type of catalyst used and the heat under which the bond is cured; the amount can be more liberal in a heat-cured bond than in a cold-setting bond. In a cold-setting bond the recommended use of wheat flour extenders is rather limited, but up to 20 per cent of walnut-shell flour gives a desirable control of flow and produces a more uniform bond strength.

In the case of fortified urea resin mixtures, the use of wheat flour ex-

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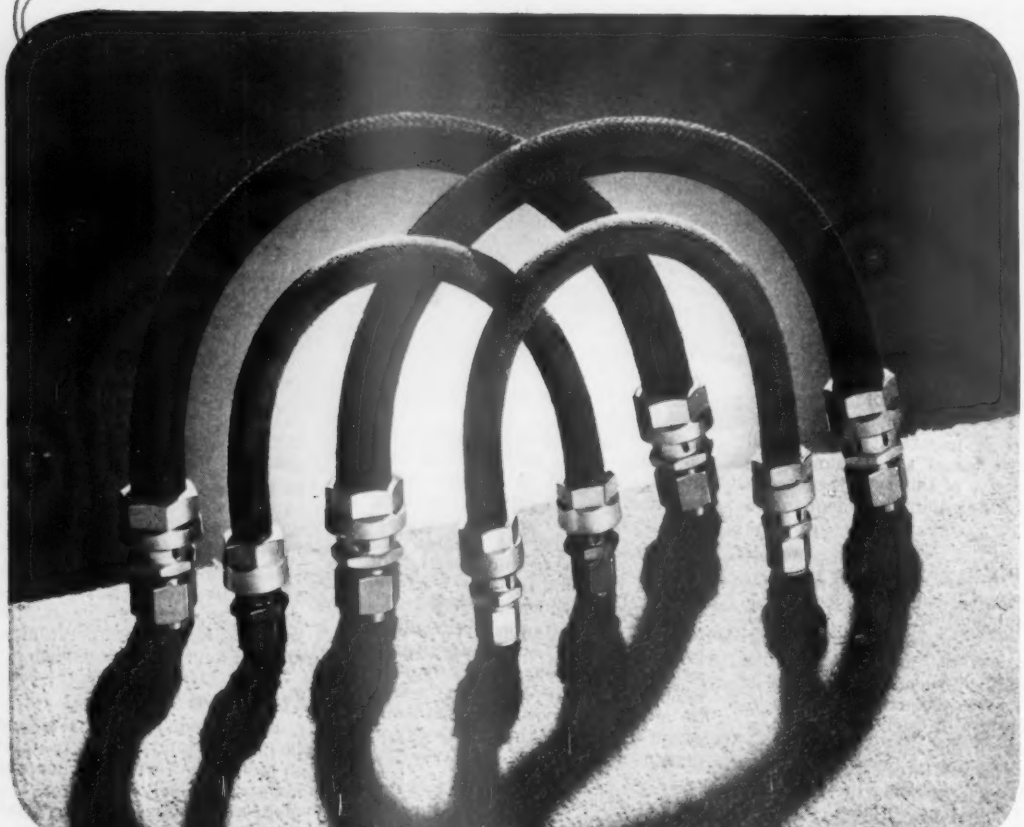

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tenders is not recommended, although up to 10 per cent of walnut-shell flour may often be found desirable.

Effects of Catalyst and Heat

Various types of catalysts are customarily used with urea resin adhesives and most of them are acidic in nature. Therefore, it is important that such catalysts be carefully chosen, since high acid content may develop a tendency to weaken the cohesion of the wood fibers. It is possible to use catalysts to regulate both the temperature requirements and the time of clamping, and these adjustments require careful study in order to determine the optimum working relation between the spreadable life of the mixture and the clamping time. Increasing the catalyst content, in some cases, will shorten the working life and reduce the necessary clamping time. On the other hand, buffers, or retarders, are incorporated in other catalysts and an increase in the amount of a buffered catalyst may increase the spreadable life and clamping requirements. Suppliers should be consulted as to the effect of varying the ratios of any catalyst.

Operational Technique on Standard (Unfortified) Ureas

Measuring, mixing, and spreading should be done accurately with clean equipment. Fast catalysts should be added immediately before use. In all of the standard ureas the working life tends to be shorter than for the phenolics and, hence, only enough should be prepared for immediate requirements. Urea resin mixtures are particularly susceptible to room temperatures above 75°F., since the addition of catalysts initiates the cycle of cure whether the glue is in the pot or spread on the veneer. In extremely hot weather the glue pot and mixer may be cooled by a water jacket, by circulating water coils, or by the use of ice packs. It is a general rule that a mixture having a 4-hour spreadable life at 75°F. will have an 8-hour life at 60°F. and a 2-hour life at 90°F.

Standard urea resin adhesives require a more generous spread than do the phenolics—usually 35 to 50 lbs. per 1,000 sq.ft. of glue joint—and, hence, double spreading becomes less necessary. It is easier to secure a more uniform penetration into both surfaces with this heavier spread. Whenever heat is not used to set or accelerate the cure the spread should be in the higher ranges, since there is no heat effect to stimulate the flow.

It is important that standard urea resin adhesives be placed under pressure while they are still tacky, although in some instances an interval of a few minutes is desirable to permit a partial evaporation of the solvent. The limit of safe assembly time is usually stated as 15 min., although this will depend on the spread, the species, the moisture content of the veneer, and the room temperature. The better rule is to be sure that tackiness is still present when the pressure is applied.

This requirement of tackiness applies to both cold set and hot set standard urea adhesives but not to fortified ureas, which will be described later. Proper schedules of bonding time, temperature, and assembly should be obtained from suppliers and should be carefully checked on any type of construction, due allowances being made for reasonable safety.

There are two general methods of employing standard urea resin adhesives: at normal room temperatures (75°F.) for assembly work, where supplementary heat (up to 150°F.) may be used to shorten the bonding time, and with hot presses or other applications of heat and pressure, where temperatures of 225° to 250°F. are obtainable. There is also a combination method where a partial cure is secured in the hot press to hold the layers of veneer together and the remainder of the cure is obtained by leaving the partially cured plywood in a hot stack.

In the case of assembly operations with standard ureas at room temperatures at 75°F., it is important that all wood parts be at or near this temperature when the adhesive is applied and that the clamped bundle be kept at that temperature or above it. Many workrooms are cool at the floor line and, since no appreciable cure will take place below 70°F., the maintenance of a suitable temperature is important to secure a proper cure. The working or spreadable life at 75°F. is from 4 to 8 hours, while the clamping time is from 6 to 8 hours, which may be progressively reduced to 2 hours if the glue-line temperature can be maintained at approximately 150°F. Special catalyst combinations can be used to reduce the clamping time but the spreadable life of the mixture will be reduced in approximately the same ratio. Less than a 2-hour working life is seldom practicable. Suppliers should be consulted for further details.

When standard ureas are used in hot bonding the temperatures are of the order of 225° to 250°F. and the minimum time is about 5 min. The catalysts used in hot bonding usually give a spreadable life of some 8 hours, except in hot weather when two mixes a day may be found necessary.

The pressures required should be enough to bring the wood surfaces into intimate contact on the glue line. As a matter of safety, a slight compression is advisable. In cold pressing, a small bead of glue should be squeezed out as an indicator of enough glue and sufficient pressure.

Operational Technique with Fortified Ureas

Certain reinforcing or fortifying reagents can be added to the catalyst to give greater durability to a urea bond. Such fortified ureas can be bonded over a wide range of temperatures—from 140°F., requiring a minimum of some 4 hours under pressure, up to 250°–300°F., where 10 min. may be adequate on thin constructions. They cannot be successfully bonded at room temperatures. Fortified ureas require predrying after spreading and before pressing. They resemble the phenolics in this regard and differ markedly from the procedure for standard ureas. There is a definite limit to the amount and type of extenders and catalysts that can be used advantageously with these fortified ureas; these should be ascertained from suppliers. Time-temperature schedules should be similarly secured.

Testing Procedures

Urea resin bonds will delaminate under exposure to excessive heat or to immersion in boiling water. Fortified urea resins may withstand boiling tests up to 2 hours. The usual tests required in Government specifications are wet and dry cycles, which are repeated according to the amount of water resistance required. Tests are usually indicated for certain standard species and constructions, which are made more useful by the accumulation of similar data from previous experience. Final tests on any type of urea bond should not be made until the assembly has been aged for at least 6 days.

Other Resin Adhesives

While most of the resin adhesives in use at the present time are either of the normal phenolic or the two urea types, there is considerable development work in progress on melamine and resorcinol types. Both are distinctly higher in cost than the phenolics or the ureas, and it will be necessary to establish definite advantages to justify the higher cost ranges. The melamines are thermosetting and are similar to the ureas, with better durability and slightly more critical operating requirements. They may be used straight but are usually combined with ureas as a fortified type. In this combination they have become well established as a supplementary resin adhesive type, somewhere between the standard ureas and normal phenolics in durability.

The resorcinols are thermosetting, are similar to the conventional phenolics, and may be combined with them to reduce the heat requirements. It is reasonable to anticipate that these combinations may become important to serve as supplementary resin adhesives in moderate temperature ranges, particularly for assembly or secondary gluing where moderate heat can be reasonably applied. Whether straight resorcinols will find a useful place will depend on relative cost and time factors, which have not yet been fully explored.

The principal type so far developed in the thermoplastic field is derived from polyvinyl butyral and has found limited use. Clamping pressure must be maintained until the resin bond is cooled below the flow temperature, and the resulting bonds are weakened on subsequent exposure to heat. At the present time this critical temperature is in the vicinity of 180° to 200°F.

They are in the higher cost ranges and, so far, have not become established as a satisfactory wood adhesive for general industrial uses.

Influence of Resin Adhesives on Plywood

Resin adhesives have become well established in the plywood industry during these last 10 years and have been instrumental in extending plywood utilization into many new fields from which the limitations of the earlier glues had barred it. The waterproofness and high moisture resistance of the resin adhesives have been outstanding advantages to the plywood consumer, and the short time interval required for completing the heat-pressure bond have been a substantial aid to the producers of plywood.

While the availability of resin adhesives has been largely limited to military uses during the war emergency, there are distinct signs that these restrictions are gradually easing. It can be confidently predicted that, after the close of the war, the advantages of synthetic resin adhesives will continue to broaden the field of plywood applications into an increasing number of civilian products. The adhesive characteristics developed under the stress of war can be more fully utilized and augmented in the industrial era that will characterize the peace.

(*Continued from page 15*)

are installed but which would, at the same time, so increase the cost of manufacture or the weight of the aircraft as to impose a severe limitation on the number of possible buyers or upon the utility they would find in the aircraft after buying it. In such cases I believe in allowing the manufacturer for the private market the widest possible range of discretion in deciding what the market will demand and be willing to pay for, and in allowing the individual buyer the widest possible freedom of choice among the products with which various manufacturers may have expressed their various appraisals of the problem—always provided that the buyer is protected against deception on the character of the article offered.

An illustration is again to be found in spinning characteristics. There must be few who would support a prohibition of the sale of aircraft capable of being spun. There must be equally few who would oppose the denial of certification to aircraft that could not be brought out of the spin after once getting in—especially if they entered the spin with particular facility. Between those extremes there is a wide range of possible cases.

In particular, we shall have to consider whether the present requirement that civil aircraft must come out of a spin of their own accord with controls released is to be maintained as of universal application. Aircraft that have been developed for military training purposes and cannot meet the present civil requirements of inherent recovery from a spin are likely to become available for private use and to be offered for certification. Should they be debarred? Personally I do not think that they should. With respect to spinning quality, as to take-off and landing performance, I believe that, except for the prohibition of the use of aircraft of which the characteristics are inherently and inevitably dangerous, the responsibility of Government should be concerned especially with making sure that the knowledge of the actual flight characteristics is available to the owner or the potential purchaser. If a pilot buys an airplane in full knowledge of the fact that it has to be brought out of a spin with the stick forward, it must be presumed that he knows how to make the recovery. That, again, like so many problems that I have raised without pretending to give a final answer, is a fit topic for debate among those versed in the design and behavior of airplanes and the training and behavior of pilots.

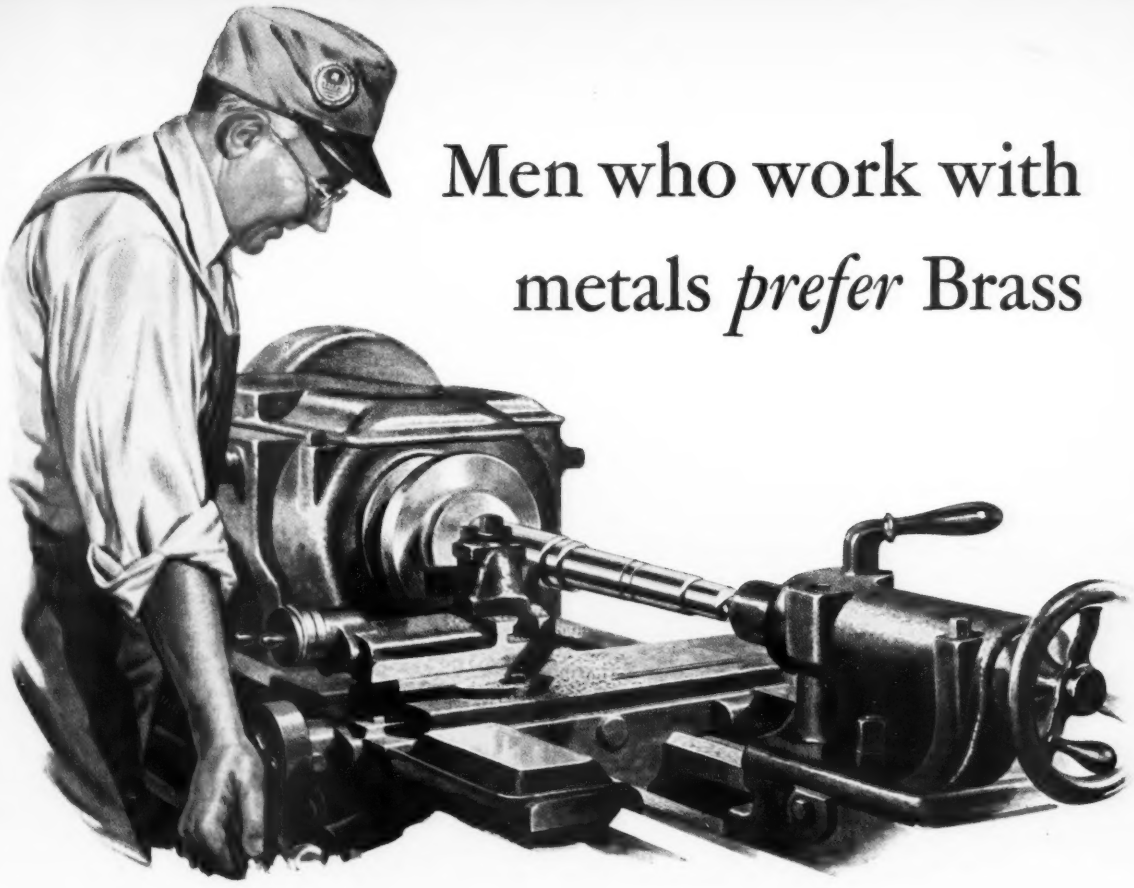
Pilot Qualifications

Among other possibilities for establishing a middle ground between full freedom of choice on the part of manufacturer and purchaser on the one hand and a universally applied Government control on the other, there is the possibility of taking account of the varying qualifications of pilots. It has sometimes been suggested that newly certificated pilots should be considered as in a probationary status, subject to special limitations and obligations until they have acquired a substantial amount of experience. It might be argued that an experienced pilot can decide for himself whether he wishes to accept the drawbacks of a personal airplane with a stalling speed of 80 m.p.h., a rate of climb of only 250 ft. per min., or some other oddity of performance, in consideration of whatever advantages might accompany those peculiar characteristics, but that machines so exacting in their demands on the pilot should at least be kept out of the hands of novices. The inexperienced pilot and the underpowered airplane have repeatedly proved themselves a lethal combination. The establishment of the most complete possible freedom of choice on the part of the experienced purchaser might be accompanied by some such provision as that pilots with less than 150 hours' experience should limit themselves to aircraft with a stalling speed of not over 60 m.p.h., a rate of climb of at least 400 ft. per min., and certain other specified characteristics. I personally shrink too much from administrative complication to wish to stand forth as the advocate of a scheme that would mean further classifications and subdivisions and more elaborately stated requirements with respect to the relation between private-flying personnel and the aircraft they are to use. Nevertheless, I do call attention to it as a possibility deserving consideration and public discussion.

A case in which I believe that the establishment of a requirement well above present standards would increase safety so substantially as to more than justify the relatively small increase in weight and production cost entailed would concern the strength of the safety belt. The present requirement is that safety belts and the structure to which they are attached must be capable of taking a load of 1,000 lbs. in one particular direction. I do not believe that anyone could examine the work done by Mr. Hugh DeHaven on the direct cause of injuries to the occupants of aircraft (as summarized by him in the paper presented at the Twelfth Annual Meeting of the Institute, January 27, 1944) and not be convinced of the desirability of at least doubling the present figure and also allowing for the load to be applied in any direction within a considerable angular range. The supplementing of the belt by shoulder straps, on the other hand, while it would make an undoubted further contribution to safety, would entail such further burdens of additional cost and complication as to classify it among the devices that ought to be provided at the buyer's option rather than by governmental compulsion.

Conclusions

In summary, my own idea is that in the next stage of evolution of the regulations affecting the design and construction of private aircraft some of the existing requirements, notably those that now impose fixed performance minimums, should be entirely eliminated. Others, notably the load factors, should be given two or more alternatives, denoted as so many different categories, with a free choice to be made by the purchaser of an aircraft in the light of the use to which he expects to put it. Much more stress should be laid upon the measurement of those elements of performance which have a special influence on safety and upon the checking of flying qualities and handling characteristics, and the resultant information ought to be recorded in a handbook supplied to each purchaser. A few detailed design requirements, especially those relating to safety-belt strength, should be tightened up. Everything that bears on liability to collision, especially the visual angles and the location of blind areas, should be critically reviewed in the anticipation that it will be necessary to maintain increasingly high standards in those respects if the record of loss of life by collision is not to become an alarming one.



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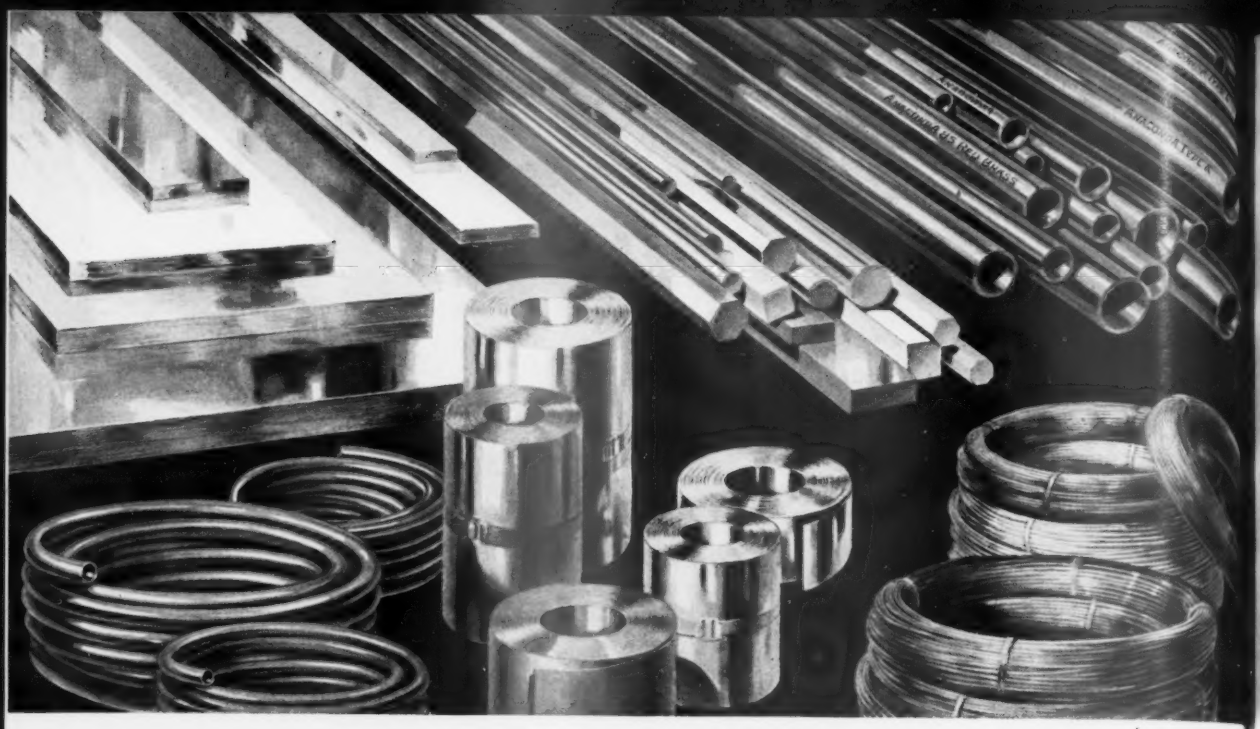

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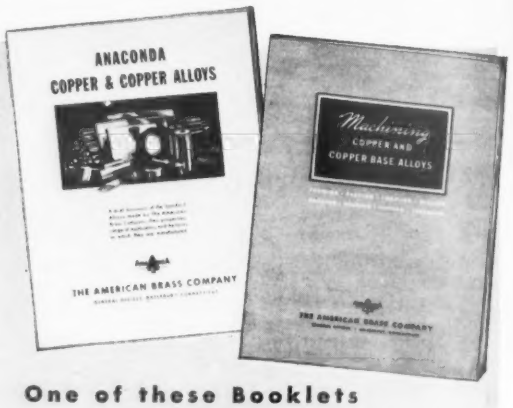

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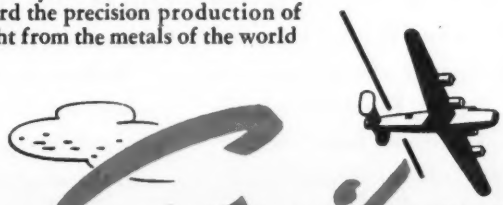

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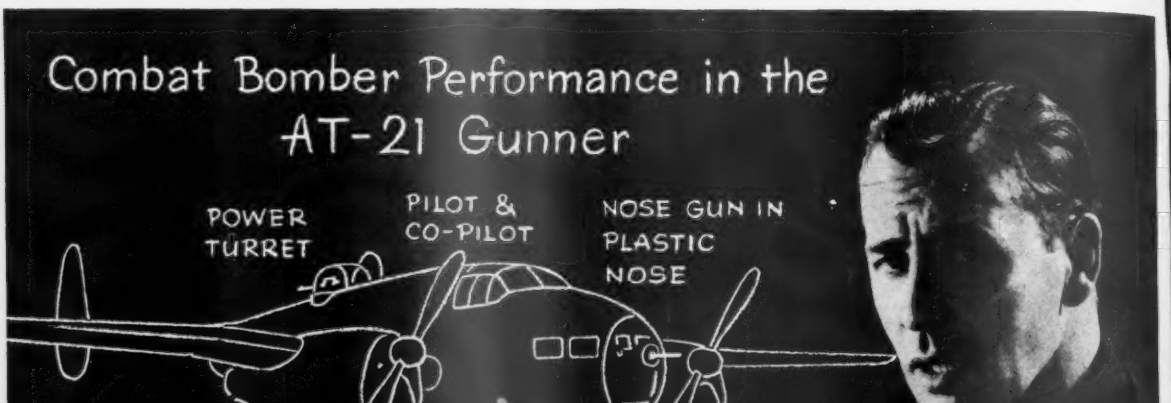

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Development of Stall Warning Indicators

JAMES GEORGE*

Civil Aeronautics Administration

ABSTRACT

This paper concerns the Civil Aeronautics Administration's development of three distinct types of stall warning devices. This work was undertaken by the Technical Development Division. Two of these instruments will be commercially available in the near future. These will function successfully under all flight conditions except when ice has accumulated on the wings and are considered suitable for use on private-owner type aircraft, since such aircraft are seldom involved in stall accidents where ice is a factor. The continuing program involves the development of the third device, suitable for use on existing air-carrier type aircraft, which will obtain an adequate warning margin even when the wings are "iced up." Results of wind-tunnel and flight tests involving all three devices are presented, and the entire problem is discussed in detail.

These devices are reliable, simple, low in cost, and easily installed and maintained. Essentially, they comprise an aerodynamically operated switch on the wing and a horn-light warning unit in the cabin. They will provide a sharp unmistakable warning of the impending stall in all maneuvers and are independent of air speed.

The first two devices are triggered at a predetermined angle of attack. One of these employing a small projecting vane is operated when the change in airflow direction at the leading edge of the wing changes from downward to upward. The other device triggers when the air pressure at an opening in the leading edge changes to a suction. This includes a diaphragm-switch unit located just inside the wing.

The continuing development involves a switch device located on the upper surface of the wing in the vicinity of the trailing edge. This device is actuated by the changing character of airflow over the wing.

Accident records indicate that more than 100 fatalities per year have resulted from stall-spin accidents.

INTRODUCTION

THE TECHNICAL DEVELOPMENT DIVISION of the Civil Aeronautics Administration is conducting a broad program involving stall warning indicators. This has already resulted in the development of two instruments suitable for private-owner type aircraft. The work is continuing.

Statistics compiled by the Civil Aeronautics Board for the year 1941 show that 134 deaths resulted from stall and spin accidents and that only 10 per cent of these involved structural or power-plant failures. That was a representative year. The number of such fatalities in the postwar period can be expected to increase in proportion to the increase in volume of air traffic unless some remedial means can be obtained. It is desired to point out that many landing and take-off accidents involved stalls. It is all too obvious that the stall, often resulting in a spin, is extremely dangerous. There is an urgent need for a reliable and practical device that will warn the pilot in a positive manner of the approaching stall.

Attempts to develop such a device date back to 1918. Since then, investigative and developmental work has been conducted by private concerns, and considerable research, including flight testing of a number of such devices, was conducted by the National Advisory Committee for Aeronautics. In 1941 the Civil Aeronautics Administration was requested by the N.A.C.A. and later by representatives of the industry to continue this work.

ANALYSIS OF THE PROBLEM

In approaching the problem it is necessary to review in detail the aerodynamics of the stall. Fundamentally, it is caused by the discontinuity of the flow over the upper surface of the wing, and for every airfoil there is a particular angle of attack at which the stall occurs. The wing then loses its required lift and the stall occurs, often resulting in a spin. When ice accumulates at or near the leading edge of the wing, the angle of stall becomes progressively smaller. In fact, the pilot is then actually flying an airplane with a different airfoil section which changes with varying ice accumulations.

A stall is essentially dependent on attitude or angle of attack of the wing relative to the wind and not on the air speed. Actually, the stalling speed of the airplane is a function of the ratio of the acceleration experienced by the airplane to the gravitational acceleration. $V_s = V_m\sqrt{1 + (a/g)}$, where:

V_s = stalling speed when the airplane experiences an acceleration a
V_m = stalling speed in level flight
a = acceleration along the vertical axis in ft. per sec. sq.
g = gravitational acceleration (approximately 32.2 ft. per sec. sq.)

It is of interest to note that in the special case of an airplane in a horizontal turn the stalling speed is a function of the angle of bank (θ).

$$V_s = V_m/\sqrt{\cos\theta}$$

An airplane in flight with the wings free of ice will stall at the same angle of attack, irrespective of air speed. Since the angle at which the stall occurs decreases progressively as ice accumulates on the wings, a device that triggers at a definite angle of attack generally should not be used on aircraft that are operated in icing conditions. However, if the wings and the instrument itself could be deiced, a device designed to function on this principle would find universal application. Accident records show that present-day air-carrier aircraft do "ice up" and that such occurrences have resulted in fatalities caused by stalling. To obtain a device that will function under such conditions, therefore, it is necessary to search for some other phenomenon from which a warning of the impending stall may be obtained. One approach involves the character of the airflow over the upper surface of the wing.

Wind-Tunnel and Flight Tests

Wind-tunnel and flight tests have been conducted with a multiplicity of streamers or tufts fastened to the upper surface of the wing in a quilted pattern so that the direction of the airflow over the entire surface was visualized by the action of the tufts. These tests were conducted both with and without simulated ice and, in some cases, have been correlated with the variation of lift coefficients with angles of attack as shown by the familiar C_L curves. From such tests it was determined that the actual stall is preceded by a local turbulence followed by a reversal in flow direction. This originates at some point along the span in the vicinity of the trailing edge.

Presented at the Radio and Instruments Session, Twelfth Annual Meeting, I.A.S., New York, January 25–27, 1944.

* Aeronautical Engineer.

plane talk

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Literature mentioned in "Plane Talk" . . . additional information on any item can be secured from any Westinghouse office, or by writing Westinghouse Electric & Manufacturing Company, Dept. 7-N, East Pittsburgh, Pa.

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It would therefore seem that an instrument that would be triggered by the initial change in airflow should provide a satisfactory stall warning indicator. However, in analyzing the correlation between tuft action and the C_L curves, it is noted that the initial appearance of flow change corresponds with the initial deviation of the C_L curve from the straight line. It therefore will be seen that the available margin between the warning and the actual stall will vary with the airfoil contour. This margin can be extremely small, since for some airfoils the final break of the C_L curve occurs shortly after its initial deviation from the straight line. Since the airfoil contour resulting from ice accretion is unpredictable, the effect of wing icing on the functioning of this type of device could be such as to reduce the warning margin to an unacceptable value. However, it is realized that there is considerable difference between full-scale and model characteristics, and it is entirely possible that the airflow and stalling characteristics of an actual airplane in flight, even when ice has accumulated on the wings, may be such as to provide an adequate margin.

Regardless of type, a stall warning indicator must be completely reliable, since, once adopted, pilots will come to depend upon it. An unreliable instrument would, therefore, constitute an actual hazard and had best be left on the ground. A satisfactory stall warning indicator must not be affected by the speed of the airplane, since, as previously discussed, the stall is strictly a function of angle of attack. This is true even when the airfoil contour has been altered by the accumulation of ice on the wing. An acceptable installation should be of such a nature as to minimize the possibility of inadvertent damage, and the warning signal should be unmistakably positive. Light weight, low cost, simplicity of construction, and ease of installation are, of course, essential.

Development Procedure

In studying the accident records it was noted that in the past 3 years air-carrier aircraft have been involved in only two accidents where stalls occurred. In both cases icing was encountered. For the same period private-owner type aircraft were involved in 512 stall accidents, only five of which involved icing. One of the air carrier accidents caused 14 fatalities. There were 374 fatalities where the stalling of private-owner type aircraft was concerned.

In view of these statistics it was considered desirable to undertake the development of a device that will function under all flight conditions, *except* when ice has accumulated on the wings, as well as the development of a universal type of instrument, since it was believed that the elimination of the consideration of ice accumulating on the wings would result in a simple, easy-to-install device that would be so low in cost as to insure its use on all private-owner type airplanes. This is believed essential, since pilots who have flown extensively in airplanes equipped with stall warning indicators might be more likely to stall an airplane when the accustomed warning was not forthcoming.

Development Programs

Realizing the urgency and magnitude of this problem the Civil Aeronautics Administration has undertaken concurrently three distinct and separate development programs in this field. In each case development contracts were let to concerns that, it is felt, not only are well qualified from a technical standpoint but will be in an excellent position to supply these devices to the industry. Each of these programs includes extensive wind-tunnel and flight tests. This has resulted in both quantitative and qualitative data necessary to the successful development of reliable and practical stall warning indicators. Two of these programs have been completed and have resulted in the development of instruments practical for use on private-owner type aircraft. The third program appears to offer some promise of resulting in a stall warning indicator that will function satisfactorily under all conditions of flight, *including* icing of the wings. It also is possible that this instrument will prove sufficiently simple and low in cost so that it will be suitable for private-owner as well as air-carrier type aircraft.

The outstanding feature of a stall warning indicator is its simplicity. There is a switch and a horn. The airflow closes the switch and the horn warns the pilot. The developments have been mainly concerned with the aerodynamic phenomena involved in actuating the switch and in reducing all components of the devices to the barest essentials. Reliability is further insured by the use of a light, in addition to the horn, as a warning means. These are combined in a single unit.

W. & L. E. Gurley

The first contract was let early in 1942 to W. & L. E. Gurley of Troy, N.Y. This involved the continued development of a leading-edge-vane type of instrument. The wind-tunnel testing that resulted in the refinement of that device was conducted at the Rensselaer Polytechnic Institute's aerodynamic laboratory. The development itself was conducted by the Gurley company.

The Power Equipment Company

In October of that year a second contract was let to the Power Equipment Company of Detroit, Mich., for the development of a diaphragm-switch arrangement, actuated by the pressure reversal at an opening in the leading edge of the wing. This development, including the wind-tunnel and flight testing, was actually conducted by the personnel of Wayne University.

United Air Lines

The possibilities of an instrument that would be triggered by the initial change in airflow characteristics on the upper surface of the wing were investigated by the National Advisory Committee for Aeronautics in 1938. A development and flight-test program involving a device of this nature was undertaken by the United Air Lines in 1940. This device was flight-tested by the Civil Aeronautics Administration in March, 1943, on the Technical Development Division's Boeing 247D airplane. Varying amounts of simulated ice were applied to the wings during those tests. However, the possibility and effect of ice accumulating on the device itself was not determined.

Westinghouse Electric & Manufacturing Company

During those tests it was shown that the warning margin provided by the United Air Lines' instrument was considerably reduced as the amount of simulated ice on the wings was increased. The serious possibilities of such a characteristic indicated the need for further development. Accordingly, in June, 1943, a contract was let to the Westinghouse Electric & Manufacturing Company, which, it is hoped, will result in a completely satisfactory means for providing an adequate warning of the impending stall either with or without ice on the wings. The Westinghouse program includes extensive investigations of the United Air Lines' instrument, other pressure-differential-actuated instruments, and flow-actuated devices. This work is being directed at the East Pittsburgh plant of the Westinghouse company. The wind-tunnel and flight tests are being conducted at the Carnegie Institute of Technology.

The W. & L. E. Gurley Instrument

In order to investigate the aerodynamic phenomena involved in the operation of the leading-edge-vane type of instrument, the W. & L. E. Gurley company arranged for the conduct of wind-tunnel and flight tests using a strip of tufts arranged around the leading edge of the wing. In these tests, as was expected, a separation point was observed so that the tufts above the separation point were deflected upward while those below were deflected downward. It also was noted that the separation point traveled downward and around the leading edge of the wing with increasing angle of attack. This phenomenon, as evidenced by the behavior of the tufts, indicates a reversal of airflow direction at the point on the leading edge where the tufts separate. It was decided, therefore, to investigate various means for utilizing this characteristic. Accordingly, several versions of a vane-type stall warning indicator were tested both in the wind tunnel and in actual flight.

This has resulted in the development of an extremely simple, low cost device consisting of a commercially available, midget-type, snap-over switch that incorporates a small actuating vane. The switch is located just inside the leading edge with a small portion of the vane projecting out into the air stream (see

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FIG. 1. Wind-tunnel test setup of tufts at leading edge showing separation point.

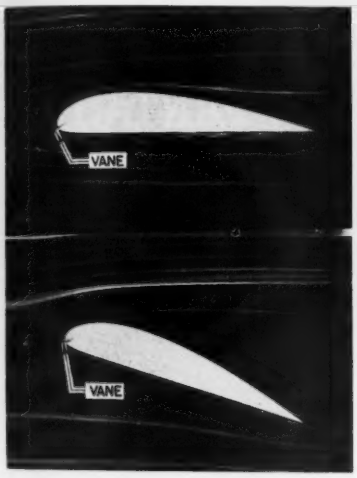


FIG. 2. Wind-tunnel test setup showing action of vane at low and high angles of attack.

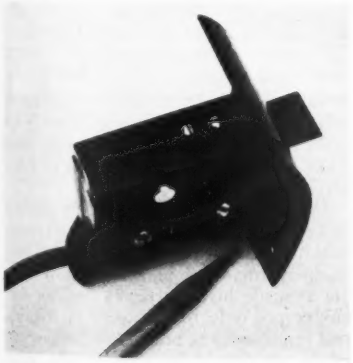


FIG. 3. Indicator head.

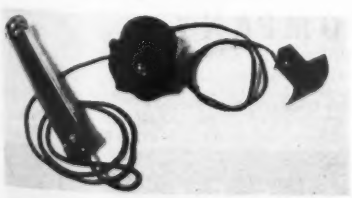


FIG. 4. Complete stall warning indicator.

Figs. 1–7, inclusive). In normal flight the vane is forced downward. When the airplane reaches a predetermined angle of attack (less than the stalling angle), the air, which has reversed direction at the point where the vane is located, forces the vane upward, thereby closing the switch. This energizes the horn-light unit in the cabin, thereby warning the pilot of an approaching stall. With this instrument no relay is required. The flight-test procedure for locating the vane with respect to the nose contour is predicated upon the fact that in level, unaccelerated flight the air speed can be used as an indication of the angle of attack. On this basis the airplane is flown at a predetermined speed (V_T) appreciably above the stalling speed (V_s). The separation point as indicated by the tufts is then noted. The vane is located at this point and will always trigger at the same angle of attack regardless of air speed. The margin between the triggering and stalling angles of attack is determined by the ratio V_T/V_s. Pilots who have flight-tested this device recommend a value of from 1.25 to 1.30 for this ratio. It is important to note that an excessive value of (V/V_s) would negate the effectiveness of a stall warning indicator, since pilots would come to disregard a warning that occurred too early. Flight tests of the Gurley instrument have included stalls in every conceivable type of maneuver. The results of those tests are shown in Table 1. It will be noted that maneuvers involving appreciable acceleration caused the airplane to stall at correspondingly higher air speeds. In every case, however, an adequate warning margin was obtained. The observed ratios (V_T/V_s) varied between 1.21 and 1.27.

The flight tests did not indicate the need for a switch unit on each wing. The use of one unit provided an adequate margin in both left- and right-hand turns. It, however, should be located midway between the fuselage and the wing tip.

Installation

The switch unit is easily installed or may be quickly replaced from the outside of the wing. It is located by a template supplied with each installation. Once installed, it cannot be tampered with because there are no adjustments. Since the vane projects only $^1/_2$ in. and since the entire unit is of unusually strong construction, it is not easily damaged. Furthermore, the switch is completely enclosed and is essentially waterproof.

The horn-light warning unit is small and light in weight and can either be mounted on the instrument panel or adjacent to it. It is operated from the airplane's battery system and requires only a moderate amount of current. Other features include self-monitoring and ease of inspection. A warning is obtained during each take-off and landing or may be obtained before take-off by lifting the vane with the finger.

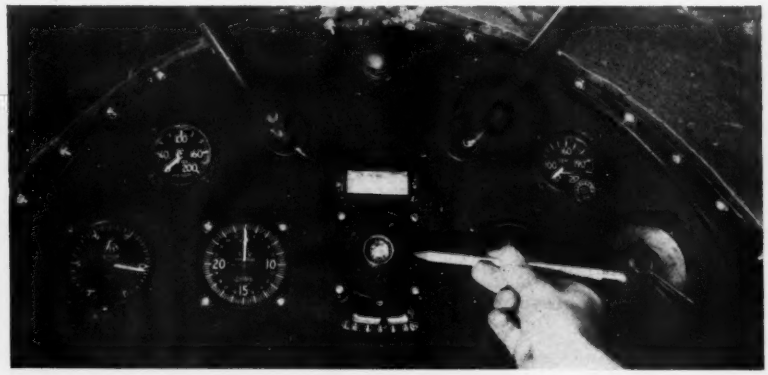


FIG. 6. Horn-light warning unit on instrument panel.

FIG. 5. Vane and attachment plate at leading edge of wing.

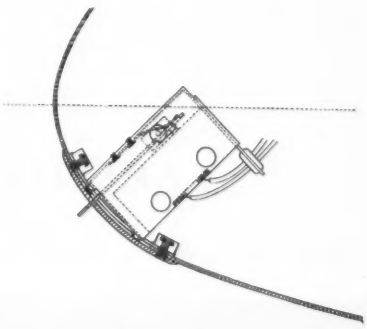
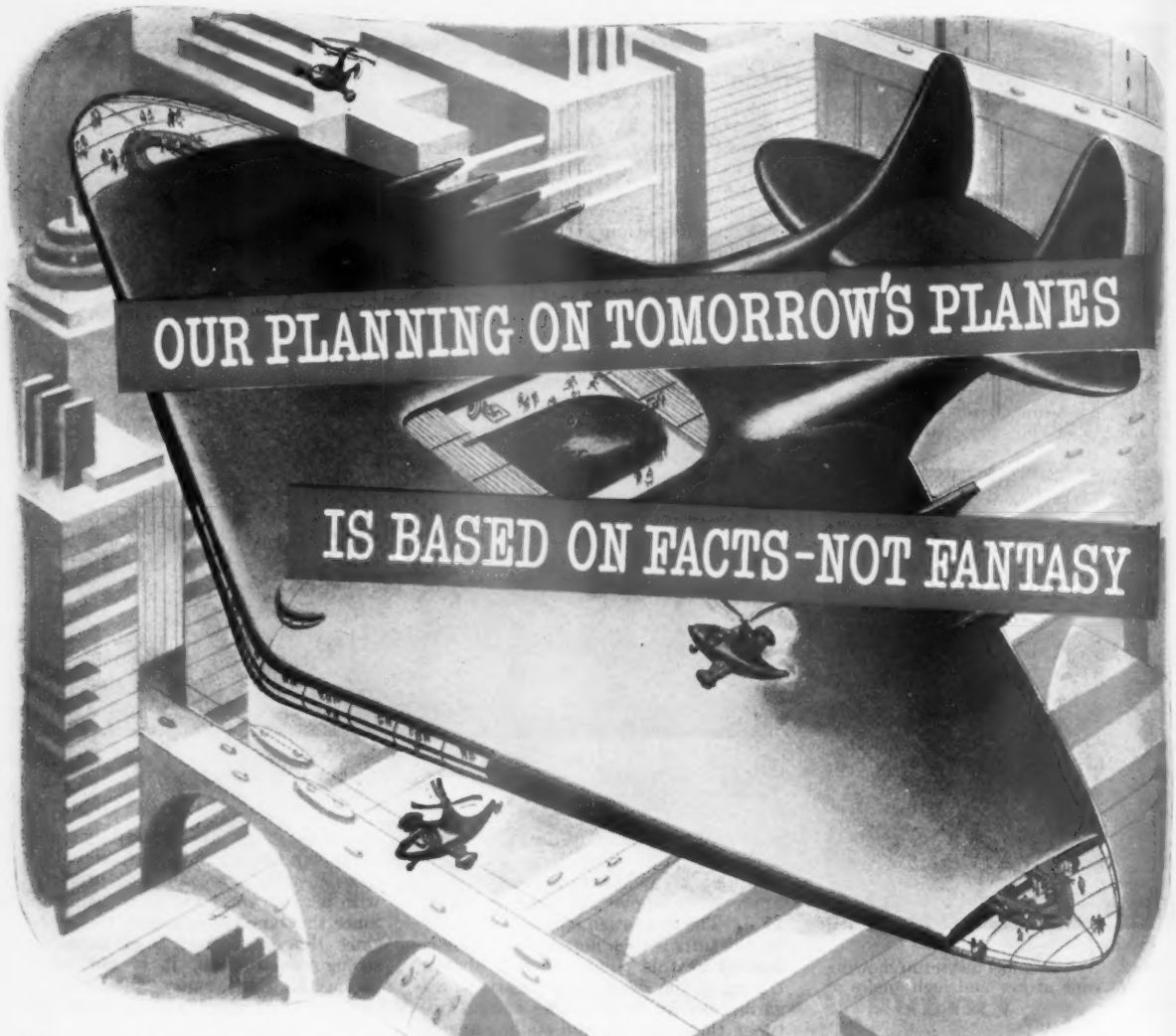


FIG. 7. Sketch showing installation of head to leading edge of wing.



PERHAPS the 1000-passenger stratoliner complete with solariums, badminton courts and swimming pool, so glibly pictured by the unhibited illustrators of the Sunday supplements, will some day sweep through a startled sky.

But we are inclined to believe that the time is still far distant.

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Working shoulder to shoulder with airframe designers and builders, and with engine and parts makers whose tremendous task today is to make America's planes the finest that fly, we are developing new and continually better products for aircraft use:—*Aircraft quality wire of every type*—stitching wire for the faster, cheaper assembly of parts—hinge-pin wire, strut and tie wire, lock wire, cotter-pin wire—bright finished, tinned or galvanized wire in carbon, alloy and corrosion resisting steels; TIGER BRAND *Control and Structural Cables* that assure perfect functioning of controls; *Springs* of all types and sizes—extension, compression and torsion springs—plane part springs, springs for precision instruments, new and special springs for the plane's fighting armament; *Cold Rolled Strip Steel* to add strength to airframe and accessory construction; *Cold Finished Bars* of aircraft quality steels, that make possible mass production of high precision parts.

Eminently practical, as nearly perfect as we can make them, these aircraft products have truly earned their wings. Their fine performance in planes that are making aviation history speaks well for our ability not only to take care of today's stiff requirements, but to meet whatever needs the unpredictable future may present.

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UNITED STATES STEEL

TABLE 1

Flight Test of C.A.A.—Gurley Leading-Edge-Vane Type Stall Warning Indicator

Trial No.	Flying Condition	Power Condition	Warning Speed, M.P.H. V_T	Stalling Speed, M.P.H. V_s	V_T/V_s	V_T/V_s Average
1 a	Level	Partial	48	40	1.20	
b	Level	Partial	50	40	1.25	1.21
c	Level	Partial	48	40	1.20	
d	Level	Partial	47	40	1.18	
2 a	Level	Cruising	49	40	1.22	
b	Level	Cruising	53	40	1.32	1.27
c	Level	Cruising	51	40	1.27	
3 a	Level	Off	48	40	1.20	
b	Level	Off	47	40	1.18	1.21
c	Level	Off	51	40	1.27	
d	Level	Off	47	40	1.18	
4 a	Left sideslip	Off	60			
b	Left sideslip	Off	55			
c	Left sideslip	Off	52		No observations of actual stalling speeds. However, an adequate warning margin was obtained.	
5 a	Right sideslip	Off	54			
b	Right sideslip	Off	51			
c	Right sideslip	Off	49			
6 a	Steep left bank	Cruising	65			
b	Steep left bank	Cruising	65		NOTE: Wind 20–30 m.p.h. gusty	
7 a	Steep right bank	Cruising	70			
b	Steep right bank	Cruising	70			
8	Landing	Off	50			

The Gurley stall warning indicator is believed to be practical for use on private-owner type aircraft. It will be commercially available in the near future.

THE WAYNE UNIVERSITY INSTRUMENT

The development of the Wayne University instrument required a knowledge of the pressure distribution around the leading edge of the wing for various angles of attack. This was determined through a series of wind-tunnel tests in which the difference in pressure between the outside and inside of the wing was determined for a series of openings arranged in a row around the leading edge of the wing. The results of those tests are shown in Fig. 8 in the form of pressure differential curves drawn in conjunction with the leading edge contour so that the normal distance from the contour to the curve shows the pressure differential at that point and at the angle of attack in question. The portions of these curves which are external to the wing contour represent a positive pressure differential from the outside to the inside of the wing, while the portions that are inside the contour represent a suction.

From these curves it will be noted that at any angle of attack there are two points on the leading-edge contour where the pressure differential is zero. It further will be noted that as the angle of attack is increased those points of zero pressure differential travel downward around the nose of the wing in such a manner that the upper portion of the leading edge suffers a pressure reversal from positive to negative while the change on the lower portion is from negative to positive. Several instruments operated by pressure reversals at two points were tested in the wind tunnel and in flight. A diaphragm-switch unit was finally developed, however, which was sufficiently sensitive to be operated by a pressure reversal at one point only. Since it was found more practical to trigger the instrument when the differential changed from a pressure to a suction, the single opening was located in the upper portion of the leading edge. The Wayne University stall warning indicator (Figs. 9 to 12) comprises a water separating unit, a connecting tube, a diaphragm-switch unit, and a horn-light unit. The water separating unit is installed in the nose of the wing and includes a pressure opening, a small drainhole, and a connection for the tube which leads to the diaphragm-switch unit. The pressure opening is $^3/_4$ in. in diameter. This is screened to prevent the ingestion of insects or other large objects, and an internal baffle is provided to prevent water droplets from entering the pressure lead.

The Diaphragm-Switch Unit

The diaphragm-switch unit is mounted on the inside of the wing just ahead of the front spar. It comprises a case within which is a slack diaphragm of a rubber-like material on which is cemented a small metal plate. The diaphragm remains flexible at temperatures as low as −60°F. When triggered by the change in pressure differential, the diaphragm is sucked upward so that the metal plate is forced against four metal contacts that are attached to the upper half of the case. These are connected to the electrical lead in such a manner that the circuit is completed if the diaphragm plate touches any two adjacent contacts. As determined through tests, the pressure differentials required to trigger this device varied from 0.015 in. of water at room temperature to 0.035 in. of water at −60°F. This high degree of sensitivity is attained through extremely low, diaphragm plate weight. The upper portion of the case is connected through the water separating unit to the opening in the leading edge, while the lower portion of the case is open to the interior of the wing.

Horn-Light Unit

The horn-light unit is self-contained, compact, and light in weight. It includes a horn, a light, a relay, a condenser, and a horn cutout button. The relay minimizes the current handled by the diaphragm contacts, while the condenser minimizes the arcing across them. The horn cutout button can be pushed during a landing to eliminate the noise

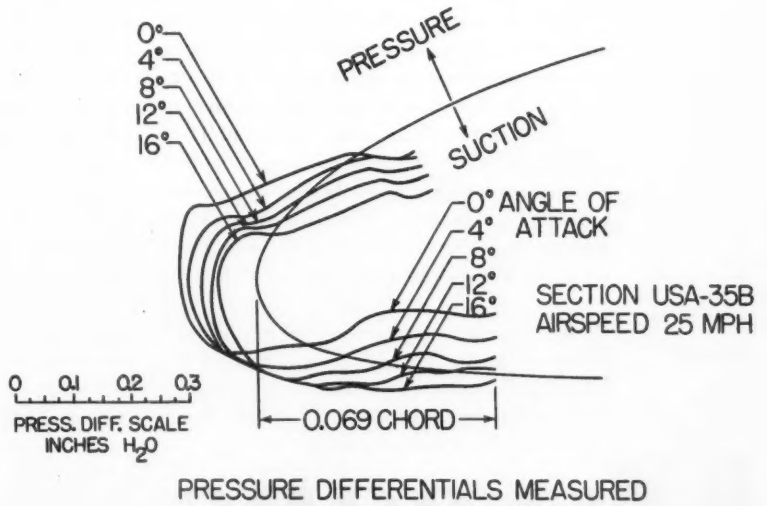

FIG. 8. Pressure reversal around leading edge at various angles of attack.

The combat plane is cherished by ground crews. The transport travels between repair shops. The private flier hugs his home field . . . But for years up in the Canadian wildernesses clear to the Arctic circle, the bush pilots broke all the rules. They packed freight and passengers over uncharted woods and waters to flyspecks on the map, flew through fog, rain and sub-zero cold without benefit of beam or beacon. They sideslipped into cubbyhole clearings, flopped their floats down on lost lakes, sat down and took off in deep snow . . . And if anything went wrong with plane or power plant, the pilot relied on a tool kit, and his own wits and skill.

LONG before the war, bush pilots put their money on Jacobs, knew the engine didn't have to be babied, stood up day after day for months on jobs that taxed the resources of both plane and pilot, were dependable at all times . . . easy starting in low temperatures, easy on fuel and parts, easy to get at for check or repair, stayed on the job longer without overhaul than any engine in its rated class.

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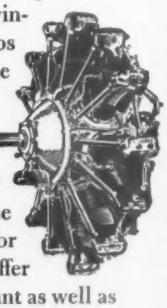

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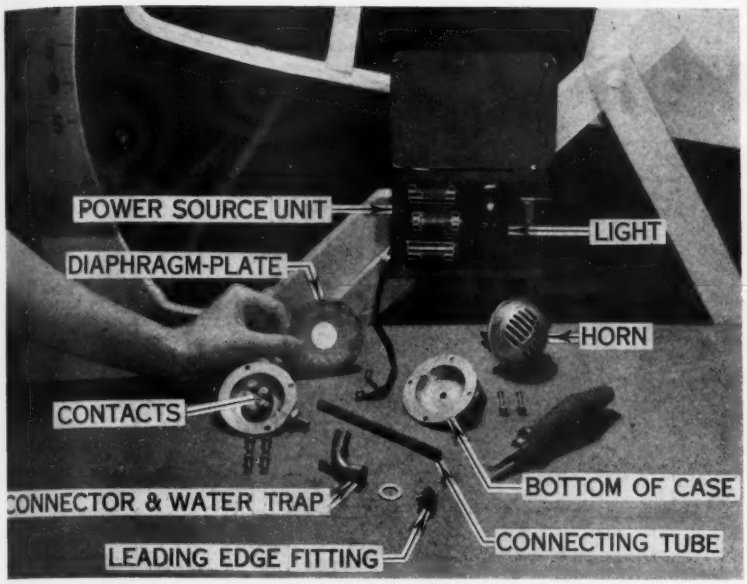


FIG. 9. Complete stall warning indicator showing component parts of head.

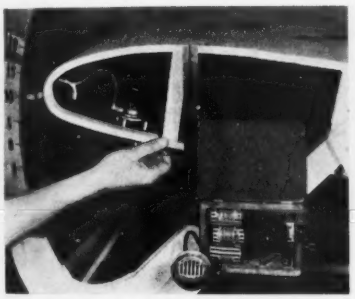


FIG. 10. Test installation of head near leading edge.

FIG. 11. Installation of horn-light unit on instrument panel.

from the horn when radio reception is critical. The light, however, is operative at all times.

Pressure Opening Location

The location of the pressure opening in the leading edge is determined through flight test in a manner similar to that used in connection with the Gurley indicator. Instead of using tufts, however, tests are conducted with various hole locations around the leading edge until a suitable warning margin is obtained. This seldom requires more than three trials for any particular type of aircraft. The location of the opening for other aircraft of that type is obtained through the use of a template supplied with each instrument. As in the case of the Gurley instrument, the use of a switch on only one wing obtains adequate functioning. It should be located midway between the fuselage and the wing tip. The results of exhaustive flight tests of this instrument, shown in Table 2, indicate an adequate warning margin in all flight maneuvers.

The Wayne University instrument is not quite so simple mechanically as the Gurley instrument. It is, however, slightly less subject to damage and its cost should be comparable. It is self-monitoring at take-off and landing and can be triggered on the ground by applying suction to the opening in the leading edge of the wing. It is believed to be practical for use on private-owner type aircraft and will be commercially available in the near future.

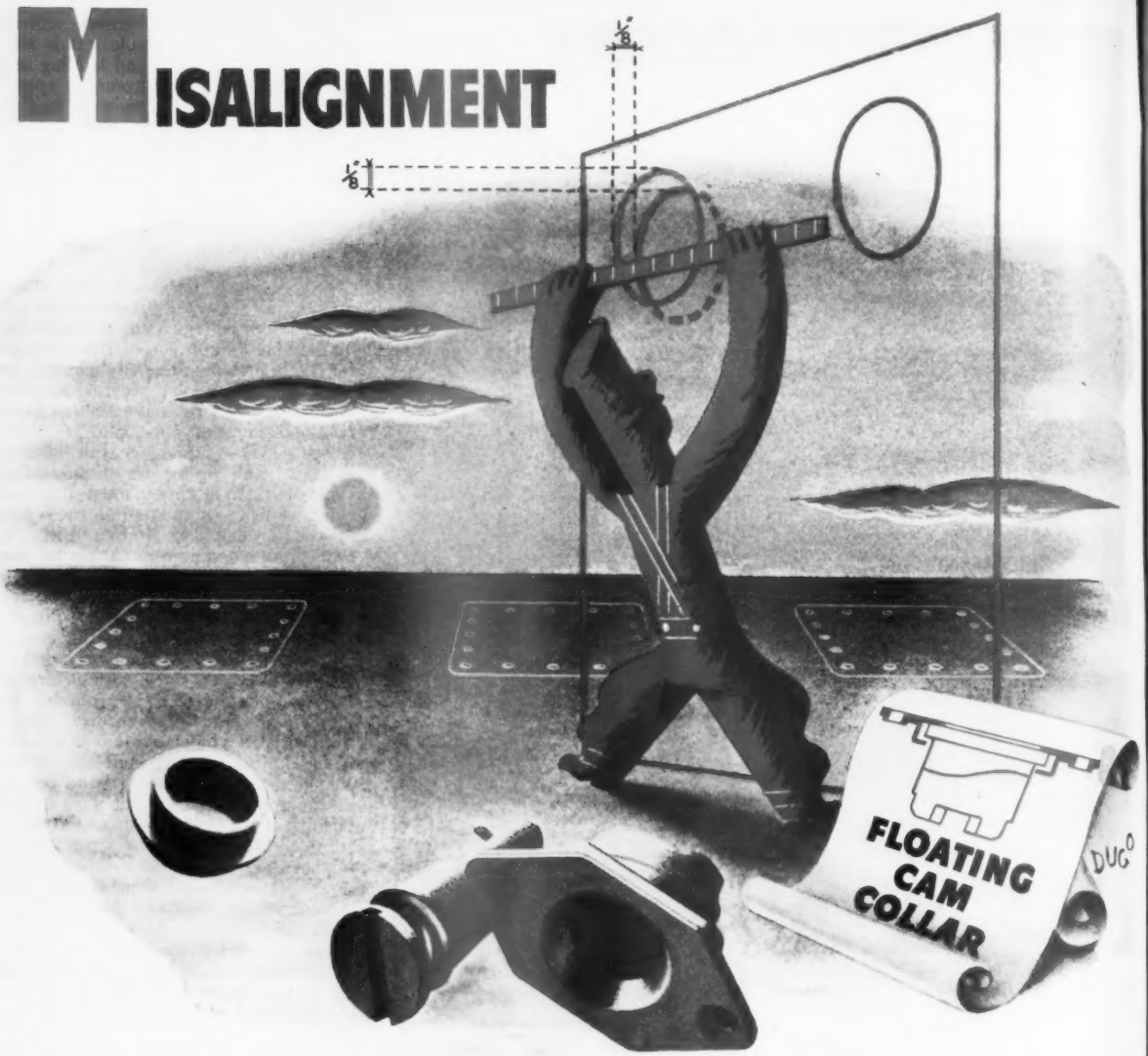
THE UNITED AIR LINES INSTRUMENT

As previously discussed, the Gurley and Wayne University instruments will not function when ice has accumulated on the wings but are considered adequate for the purpose intended because, as shown by the accident records, private-owner type aircraft have seldom been involved in stall and spin accidents where ice was a factor. A stall warning indicator suitable for use on air-carrier type aircraft, however, must function when ice has accumulated on the wings as well as when they are free of ice. A number of possible approaches to this problem were considered by the Civil Aeronautics Administration and, for various reasons, discarded. It finally was determined that a device that would be triggered by the change in airflow characteristics on the upper surface of the wing offered the most promise. As previously discussed, however, flight tests with tufts indicated that as the airplane approaches the stall the initial change in airflow characteristics occurs on the upper surface of the wing in the vicinity of the trailing edge and at some point or points along the span. They further showed that the spanwise locations of these points depend upon the geometry of the wing and that they may shift during flight. This shift may be caused by opening or closing the throttles of outboard engines, by raising or lowering the landing gear or flaps, or by the location and character of ice accretion.

In every case, however, the area over which the airflow direction reversed was

FIG. 12. Location of pressure opening on leading edge of wing.

MISALIGNMENT



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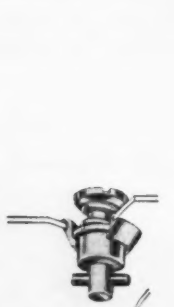

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TABLE 2

Flight Test of C.A.A.—Wayne University Leading-Edge-Pressure-Reversal Type

Trial No.	Flying Condition	Power Condition	Warning Speed, M.P.H. V_T	Stalling Speed, M.P.H. V_s	V_T/V_s	V_T/V_s Average
1 a	Level	Power on	58	50	1.16	
b	Level	Power on	60	50	1.20	
c	Level	Power on	55	48	1.15	
d	Level	Power on	57	50	1.14	
e	Level	Power on	58	52	1.12	1.16
f	Level	Power on	57	50	1.14	
g	Level	Power on	60	51	1.18	
h	Level	Power on	58	50	1.16	
2 a	Left sideslip	2/3 r.p.m.	65	55	1.18	
b	Left sideslip	2/3 r.p.m.	60	50	1.20	
c	Left sideslip	2/3 r.p.m.	60	50	1.20	
d	Left sideslip	2/3 r.p.m.	60	50	1.20	
e	Left sideslip	2/3 r.p.m.	61	50	1.22	1.19
f	Left sideslip	2/3 r.p.m.	60	50	1.20	
g	Left sideslip	2/3 r.p.m.	65	55	1.18	
h	Left sideslip	2/3 r.p.m.	64	55	1.16	
i	Left sideslip	2/3 r.p.m.	65	54	1.20	
j	Left sideslip	2/3 r.p.m.	66	55	1.20	
3 a	Right sideslip	2/3 r.p.m.	65	55	1.18	
b	Right sideslip	2/3 r.p.m.	65	55	1.18	
c	Right sideslip	2/3 r.p.m.	55	50	1.10	
d	Right sideslip	2/3 r.p.m.	60	50	1.20	
e	Right sideslip	2/3 r.p.m.	61	50	1.22	1.19
f	Right sideslip	2/3 r.p.m.	65	55	1.18	
g	Right sideslip	2/3 r.p.m.	64	52	1.23	
h	Right sideslip	2/3 r.p.m.	66	55	1.20	
i	Right sideslip	2/3 r.p.m.	68	55	1.24	
4 a	Steep left bank	Power on	80	70	1.14	1.12
b	Steep left bank	Power on	75	68	1.10	
5 a	Steep right bank	Power on	75	65	1.16	1.13
b	Steep right bank	Power on	75	68	1.10	

observed to progress forward over the wing as the angle of attack was increased. It was immediately evident that the warning margin that would be provided by any instrument that is triggered by the change in airflow characteristics will vary with its chordwise location and that for air-carrier type aircraft, in particular, a number of these instruments should be distributed along the span.

Since the United Air Lines was developing a device of this nature, it was considered advisable for the Civil Aeronautics Administration to cooperate with that company. Accordingly, in the spring of 1943 arrangements were made for the conduct of flight tests of the United Air Lines instrument on the Technical Development Division's Boeing 247D airplane.

Operation and Construction

The instrument flight tested by Civil Aeronautics Administration personnel is essentially a diaphragm-switch arrangement that operates on the change in pressure differential induced by the change in airflow characteristics. This was developed by United Air Lines after flight tests of various preliminary types and is so constructed that the vertical diaphragm and its casing are submerged in the wing. The portion of the casing on one side of the diaphragm is open to the interior of the wing, while the other portion, through a suitable means, is communicated to the airflow over the surface of the wing. In normal flight there is a pressure drop from the inside to the outside of the wing which holds the electrical contacts open. As the stall is approached, however, there is a change in this pressure differential which causes the diaphragm to move so as to close the contacts. In the United Air Lines instruments a small spring was employed which closes the contacts when the pressure differential is sufficiently reduced.

The functioning of this type of instrument is dependent upon the aerodynamic form of the "means" which communicates the diaphragm casing to the airflow over the wing. The instrument flight tested incorporated a small tube that projected beyond the surface of the wing. This was covered by a small streamline shell that incorporated a louver-like opening at its highest point. The tube then communicates with the casing, thus serving to transmit the pressure differential, and also acts as a stand pipe to prevent water from entering. A small drain hole at the rear of the device communicated with the interior of the wing. This instrument is shown in Figs. 13 and 14.

The possibility of ice accumulating on a streamlined protuberance of this nature must be carefully considered, since it could create a local turbulence that would result in a false warning signal. However, flight tests of this instrument conducted by the United Air Lines' personnel on a DC-3 airplane in icing conditions indicated that moisture particles would be deflected over the protuberance. The possibility of such local icing in connection with other aircraft is yet to be determined.

Installation

The installation of the United Air Lines stall warning system involves the use of several diaphragm-switch units located at different points along the span and a corresponding number of warning lights on the instrument panel. The electrical circuits are so arranged and the springs in the diaphragm-switch units are so adjusted that, during normal flight conditions and with no ice, a sequence of warnings will occur at progressively smaller margins between each warning and the actual stall. This is intended to inform the pilot as to the progress of the stall.

Flight Tests

In order to determine the number and location of wing units for the Boeing, flight tests with tufts were conducted. The results of those tests are shown in Fig. 15 for the power-on and power-off conditions. This illustrates the manner in which the spanwise location of the point where the initial change in flow characteristics occurs can shift during flight and the manner in which this flow régime progresses over the wing. As a result of those tests, four diaphragm-switch units were located on the left wing as shown in Fig. 16. This installation was tested in various maneuvers

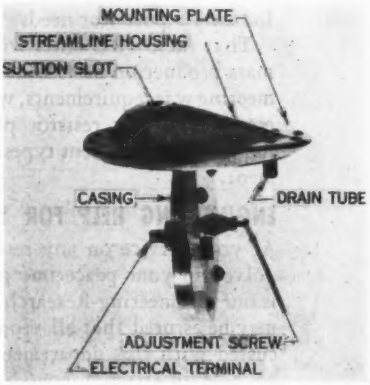

FIG. 13.

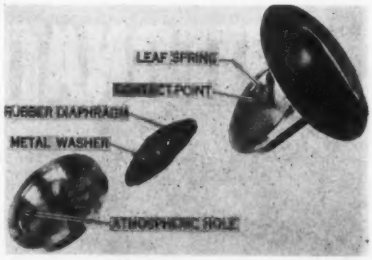

FIG. 14. Component parts of indicator.

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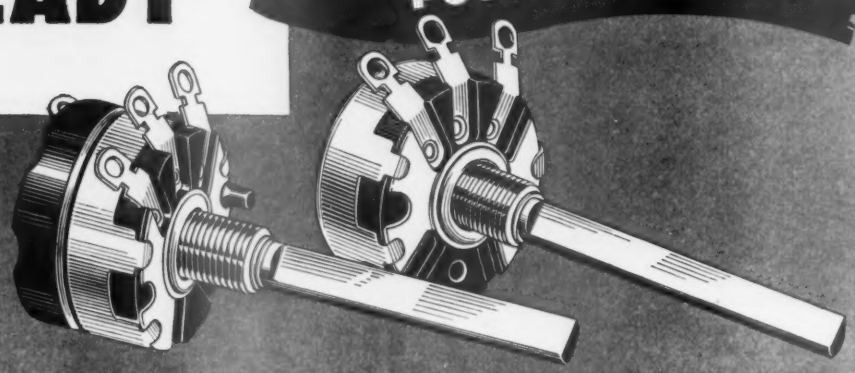

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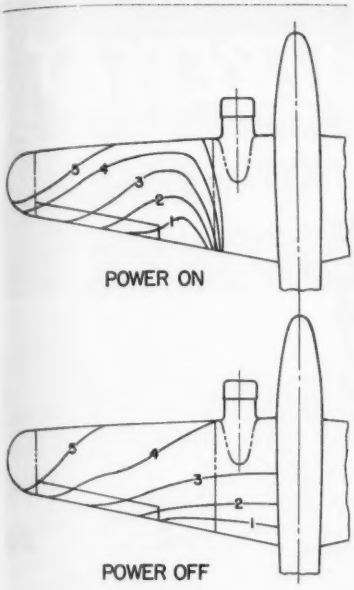

FIG. 15. Progress of stall on Boeing 247D airplane as evidenced by tuft action during flight tests.

and with varying amounts of simulated ice on the leading edge of the wing. The results of those tests are listed in Table 3 from which it will be noted that the margin between the speed at which the initial warning occurred (V_T) and the speed at which the stall occurred (V_s) expressed as the ratio (V_T/V_s) varied from a maximum of 1.64 to a minimum of 1.06 as the amount of simulated ice was increased. This reduction in warning margin is somewhat disturbing, particularly when it is remembered that the maximum amount of simulated ice applied for the purpose of the tests only approaches the amount of natural ice that might be accumulated in flight and that the airfoil contour resulting from the accretion of natural ice is impossible to predict. To date, no flight tests have been conducted with the Boeing under actual icing conditions. After studying the results of those flight tests it was felt by all concerned that the Civil Aeronautics Administration should undertake a comprehensive development program that would include instruments triggered by the change in characteristics of the airflow over the upper surface of the wing. Accordingly, and as previously discussed, a contract was let to the Westinghouse Electric & Manufacturing Company for this work, which is now being conducted at East Pittsburgh, Pa.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY PROGRAM

The Westinghouse program involved wind-tunnel and flight tests which already are yielding quantitative data concerning pressure differentials induced by the airflow as well as the nature of the airflow itself. A Piper Cub Cruiser has been obtained and has been especially modified for this purpose. The wind-tunnel tests are being conducted at the Carnegie Institute of Technology's $4^1/_2$ ft. open throat tunnel with various types of instruments mounted on a model wing of 39-in. chord by 8-ft. span. The wing used for wind-tunnel tests has a U.S.A.-35B (modified) airfoil section, the chord being 39 in. which is approximately half scale. Only the center portion of the wing is utilized for test purpose.

Test Program

The test program includes a tuft survey and the obtaining of pressure differentials utilizing full-scale and half-scale wing "blisters" having various aerodynamic contours. The four types of "blisters" are shown on Fig. 17

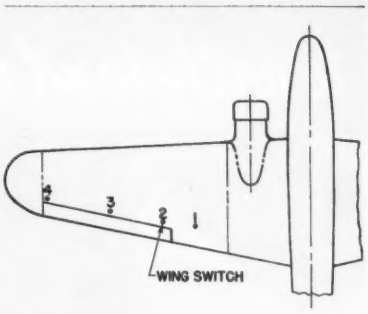

FIG. 16. Location of stall warning indicator switches on Boeing 247D airplane during flight tests.

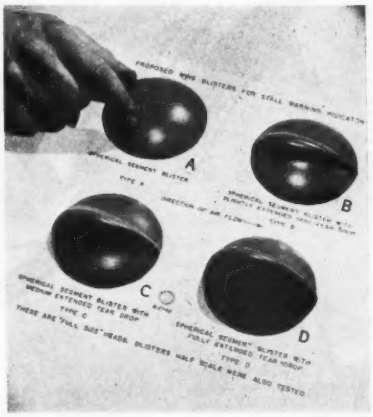

FIG. 17. Types of blisters used in wind-tunnel tests.

TABLE 3

Flight Tests of United Air Lines' Stall Warning Indicator

	Level Flight											
	Wheels up						Wheels down					
	Power off			Power on			Power off			Power on		
Amount of Ice	Warning speed, m.p.h. V_T	Stalling speed, m.p.h. V_s	Initial margin % above stall V_T/V_s	Warning speed, m.p.h. V_T	Stalling speed, m.p.h. V_s	Initial margin % above stall V_T/V_s	Warning speed, m.p.h. V_T	Stalling speed, m.p.h. V_s	Initial margin % above stall V_T/V_s	Warning speed, m.p.h. V_T	Stalling speed, m.p.h. V_s	Initial margin % above stall V_T/V_s
A	80	55	1.45	82	56	1.46	95	61	1.56	100	61	1.64
B	80	59	1.36	80	60	1.33	93	70	1.33	92	70	1.31
C	90	70	1.29	86	72	1.20	97	82	1.18	95	81	1.17
D	90	71	1.27	89	70	1.27	95	85	1.12	95	82	1.16
E	90	76	1.18	92	71	1.30	100	95	1.05	100	90	1.11

	30° Banking					
	Wheels up Left turn			Power on Right turn		
Amount of Ice	Warning speed, m.p.h. V_T	Stalling speed, m.p.h. V_s	Initial margin % above stall V_T/V_s	Warning speed, m.p.h. V_T	Stalling speed, m.p.h. V_s	Initial margin % above stall V_T/V_s
A	88	65	1.35	82	62	1.32
B	82	72	1.14	84	66	1.27
C	89	69	1.29	82	70	1.17
D	86	71	1.21	85	75	1.13
E	90	73	1.23	87	71	1.23

Legend:
A—no ice
B—$^1/_2$-in. ice (nacelle to midway on wings)
C—$^1/_2$-in. ice (tip to tip)
D—$1^1/_2$-in. ice (nacelle to midway) $^1/_2$-in. ice (to tips)
E—$1^1/_2$-in. ice (tip to tip)

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These blisters are so constructed as to eliminate the necessity for providing reinforced openings in the upper surface of the wing, since the diaphragm-switch arrangements are incorporated in the blisters themselves. The United Air Lines type of "blister" is included in these tests. Flow actuated devices are also being tested. The effect of chordwise location and "blister" height is being explored through a suitable range of angles of attack of the wing and at tunnel velocities of 40 and 80 m.p.h. Tests with varying amounts of simulated wing ice also are being conducted. The wind-tunnel results obtained to date are shown in Figs. 18 and 19.

The curves shown on Fig. 18 indicate the variation in pressure differential of the same "blister" due to a change in air speed. It is worthy of note that, commencing at a particular angle of attack and continuing thereafter for a certain angle of attack increment, the pressure differential is independent of air speed and is a function of angle of attack only.

This phenomenon of the dependence of pressure differential only on angle of attack is fundamental and necessary in the successful development of a stall warning indicator. The curves on Fig. 19 show the variation of pressure differentials due to the various types of "blisters." A study of these curves indicates that "blister" type "B" shows a reversal of pressure in advance of types "C" or "D," thereby suggesting that "blister" "B" might be preferable to the other two types in that it may allow a greater warning margin if used as an indicator.

As far as is safe and practical, the flight tests will parallel the wind-tunnel tests and comparable data will be obtained. Tuft surveys will be made, and pressure differentials using the same "blisters" that were tested in the tunnel will be tested and both the angles of attack and air speeds will be measured. Although no flight tests with simulated ice are contemplated, it is planned to conduct flight tests at freezing temperatures using a localized water spray to determine the icing tendencies of the "blisters" themselves. The more promising types of devices will be tested with electrical contacts installed to determine their triggering characteristics.

It is hoped that a study of the quantitative and other data obtained from those tests will lead to the development of a stall warning indicator that will provide an adequate and substantially uniform warning margin with or without ice on the wings and which will be so simple and low in cost that it will be used on both private-owner and air-carrier type aircraft.

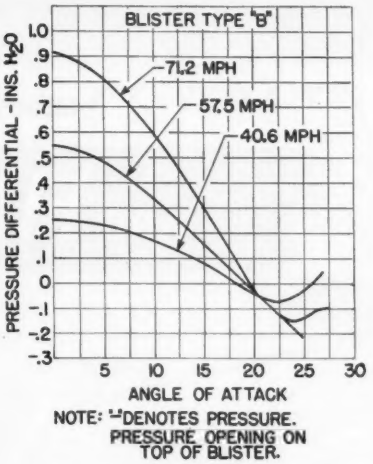

FIG. 18. Pressure-differential curves of "blister" "B" derived from wind-tunnel tests.

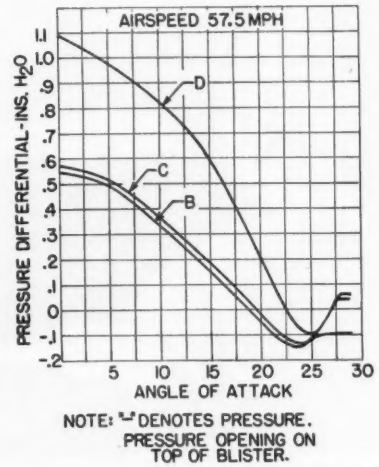

FIG. 19. Pressure-differential curves of "blisters" "B," "C," and "D" derived from wind-tunnel tests.

CONCLUSIONS

To date and as a result of the coordinated efforts of all concerned, two reliable, simple, and low-cost stall warning indicators that will function satisfactorily when the wings are free of ice will be commercially available in the near future. The C.A.A. program is continuing in an effort to develop an equally practical instrument that will provide a suitable warning of the impending stall even when ice has accumulated on the wings.

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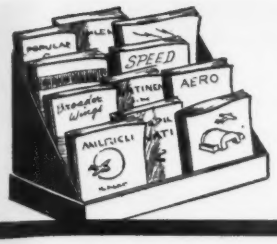

Periodicals

Accessories and Equipment

Design of Aircraft Fuel Systems. Part 3. C. Stewart Brandt. The concluding installment of a three-part article on designing fuel systems for airplanes deals with the supply section of the fuel system. With advice given about pertinent points to be considered in the design of new installations, the following supply-section components are discussed in detail: auxiliary and fuel booster pumps; centrifugal booster pumps; positive-displacement, vane-type booster pumps; auxiliary pumps; piping; selector valves; cross feed; master fuel strainers; engine-driven fuel pumps; pressure-reducing valves; check valves; auxiliary fuel systems; quick disconnects; and fire-prevention valves. The installment also considers the question of vapor loss at high-altitude and low-temperature operation. In conclusion, a special study has revealed that the cause of engine surging, loss of power, and other troubles is vaporization of the fuel. In some instances this occurs far below the normal vapor-locking altitudes in the carburetor, the metering chamber, and the jets. There are three reasons for the trouble: (1) excessive heat pickup between the engine pump and the carburetor; (2) the turbulence that the carburetor imparts to the fuel passing through it; (3) the pressure loss imparted to the fuel by the carburetor. Remedies suggested are: (1) reduction of the heat pickup; (2) raising the working pressure of the system; (3) the use of a centrifugal-type booster pump that will separate almost all of the vapor from the fuel before the fuel leaves the tank. *Aero Digest*, April 15, 1944, pages 116, 118, 123, 126, 128, 130, 132, 135, 5 illus.

Ducts. Carl J. Rother. How airflow is put to work and controlled in modern aircraft is described in this article on air ducts. The writer outlines the way complex physical problems connected with directing the airflow to oil coolers, turbosuperchargers, intercoolers, and carburetors are solved. An auxiliary cooling system ready for a laboratory test is illustrated. *Air Trails*, May, 1944, pages 21, 22, 80, 6 illus.

Metal Plus Plastic Makes New Aircraft Flooring. The characteristics and advantages of Panelyte aircraft flooring and its development by The Glenn L. Martin Company are described. Constructed to meet the requirements for a flooring of minimum weight as compared to strength, Panelyte is molded from a high-strength, canvas-base, laminated phenolic material. Because of its high-strength characteristics, a design similar to corrugated aluminum flooring is used. However, aluminum inserts are incorporated in the lower portion of the webbing to offset certain tension-failure difficulties of this web structure. The development of this flooring also fulfilled specifications that (1) no special procedure or bracing be required for installation; (2) attachment be obtained with standard fasteners, such as screws, rivets, or Dzus fasteners; and (3) the supports consist of transverse frames 10 to 20 in. apart. Specifications for the strength characteristics consisted of minimum EI values, ultimate moment loads, and heel-pressure loads. It is reported that Panelyte requires no painting or rubber matting. In addition to illustrations of the metal-plastic flooring, the article is supplemented by a table of its sizes and strength, a table of its physical characteristics, a cross-section drawing with dimensions and a heel-load diagram. *Aviation*, April, 1944, pages 130, 131, 240, 243, 6 illus.

The A to Z of Servicing Cuno Filters. With photographs and "exploded" sketches accompanying the directions, methods of servicing Cuno filters are detailed. The article begins by describing the different types of filters and identifying the filter parts. It then proceeds with advice on installation, inspection, and maintenance, followed by overhaul instructions and particulars on hydraulic-motor overhaul. The final portion of the article deals with the procedures of reassembly. *Aviation*, April, 1944, pages 157–163, 287, 289, 291, 16 illus.

Mass Producing Aircraft Injection Carburetors. An account of how the Bendix Aviation Corporation manufactures Stromberg injection carburetors for aircraft. In addition to details on factory methods and machine equipment, the article contains a description of the injection carburetor. Notes are also included on Bendix's production of Stromberg float-type aircraft and tank carburetors, the adaptation of the company's carburetor-manufacturing principles by British firms, and the carburetor-maintenance services performed by Bendix for the armed forces. *Industrial Aviation*, April, 1944, pages 30, 31, 44, 5 illus.

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AERO— MAGNETTE

Field Maintenance of Bosch Magnetos. A comprehensive description of the maintenance methods that are advised for keeping Bosch magnetos at their maximum efficiency. Step-by-step details are given in the procedures of inspection, removal, installation, timing, and synchronization. Schematic drawings illustrate the discussed methods. *Aviation*, April, 1944, pages 164–167, 11 illus.

Aerodynamics

The Determination of Fuselage Monuments. C. E. Pappas. The purposes of this paper are to present theoretical coefficients of additional apparent mass for an ellipsoid of three unequal axes and to indicate the change in the theoretical coefficients when boundary layer, interference, and turbulence effects are considered. In order to determine the effect of a viscous, incompressible fluid on the additional apparent mass coefficients, wind-tunnel tests on circular fuselages alone and in combination with a wing were used to determine the extent of the variation in the theoretical coefficients.

The writer attempts to give the necessary theory associated with the concept of additional apparent mass so that the reader may better understand the actual variation of moment of a body moving in a viscous fluid in terms of the mass coefficients. The subject is dealt with in sections discussing the concept of additional apparent mass, fuselage moments for a body of revolution, and fuselage moments for an elliptical fuselage (ellipsoid of three unequal axes). *SAE Journal*, May, 1944, pages 183–190 (Transactions), 14 illus.

The Aerodynamic Development of Axial Flow Fans. T. H. Troller. The characteristics of the axial flow fan are noted and its development up to the present is reviewed. It is stated that aerodynamic design of axial flow fans is an achievement of aerodynamic science founded on the employment of airfoil sections, the characteristics of which have been well established in a great number of wind-tunnel tests. The expected future performance of axial flow fans is discussed, and certain absolute limits of performance are investigated. Consideration is given to the aerodynamics of fan noise and to the installation of fans.

In conclusion, it is stated that the axial flow fan is essentially based on the aerodynamics of airfoils. Its performance may be further improved by a still better understanding of the forces developed on airfoils, by increased knowledge regarding the details of the pressure and of the sound field created by the rotating airfoils, and by the utilization of improved sections in the design of fan blades. Careful study of the fan installation will make certain that the fan operates as well as its test-stand performance would indicate. *Heating, Piping & Air Conditioning*, April, 1944, pages 224–231, 13 illus.

Boundary Layer Control. A description is given of how improved airplane performance can be obtained by controlling the boundary layer in the region adjacent to the skin of the aircraft, thereby reducing the drag. It is then explained that in an aircraft equipped with a turbo-unit the necessity for providing an air intake for the turbine can be turned to advantage by arranging the inlet to exert an influence on the boundary layer airflow. How the boundary layer can be controlled by the application of suction is described and illustrated diagramatically. The utilization of the exhaust gas from conventional aircraft engines to control the boundary layer also is discussed. Illustrations show the 1936 Bristol exhaust-actuated boundary-layer control and the Prandtl and Baumann proposals for boundary-layer control incorporated into a finely streamlined aircraft propelled by jet reaction. *Flight*, March 9, 1944, pages 260–262, 8 illus.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

Air Cargo

Looking Ahead to Air Cargo Markets. Part I. Robert K. Kinzel. An evaluation of the potentialities and limitations of future air-cargo markets. Indicating certain advantages the air-transport company will have to offer the shipper in order to compete with the lower costs of surface transportation, the writer discusses probable postwar rates for carrying air cargo, types of cargo that will be shipped at those rates, and the kinds of planes that will be used. Consideration is given to the amount of air-cargo business that may be expected in the United States, as well as between the United States and South America, Europe, Asia, and Africa. Emphasis is placed upon the fact that, since the outbound flow of air-shipped commodities to Africa, South America, and the Orient will undoubtedly be heavier than the inbound flow, inducements must be offered to increase business for the return trips with the purpose of reducing the overall rate structure. *Aviation*, April, 1944, pages 176, 177, 251, 253, 2 illus.

Reducing Tare Weight of Air Cargo Shipments. Ralph E. Oursler. From an analysis of one company's air shipments over a period of 4 days, it is shown how great savings in tare weight can be effected through improved packing methods and more efficient use of packaging materials. Four tables list the results of the study. One gives examples of suggested improvements in packing specific items; the other three are reports on weights and ratios, potential tare-weight reductions, and the tare-weight differences between present and recommended packaging methods. The shipments under study are Lockheed Army Air Transport shipments. *Flying*, May, 1944, pages AC-5–AC-7, 4 illus.

Speed by Efficiency Should Rule Postwar Cargo Handling. George T. Rutledge. Present cargo-handling problems and considerations for the future are considered. It is noted that building, ramp, equipment, and transport-plane design are all interrelated in cargo handling. The writer discusses problems connected with the building of efficient terminals, the coordination and organization of cargo-handling problems, containers for cargo, and cargo-plane design. *Air Transport*, April, 1944, pages 40–42, 45, 47, 7 illus.

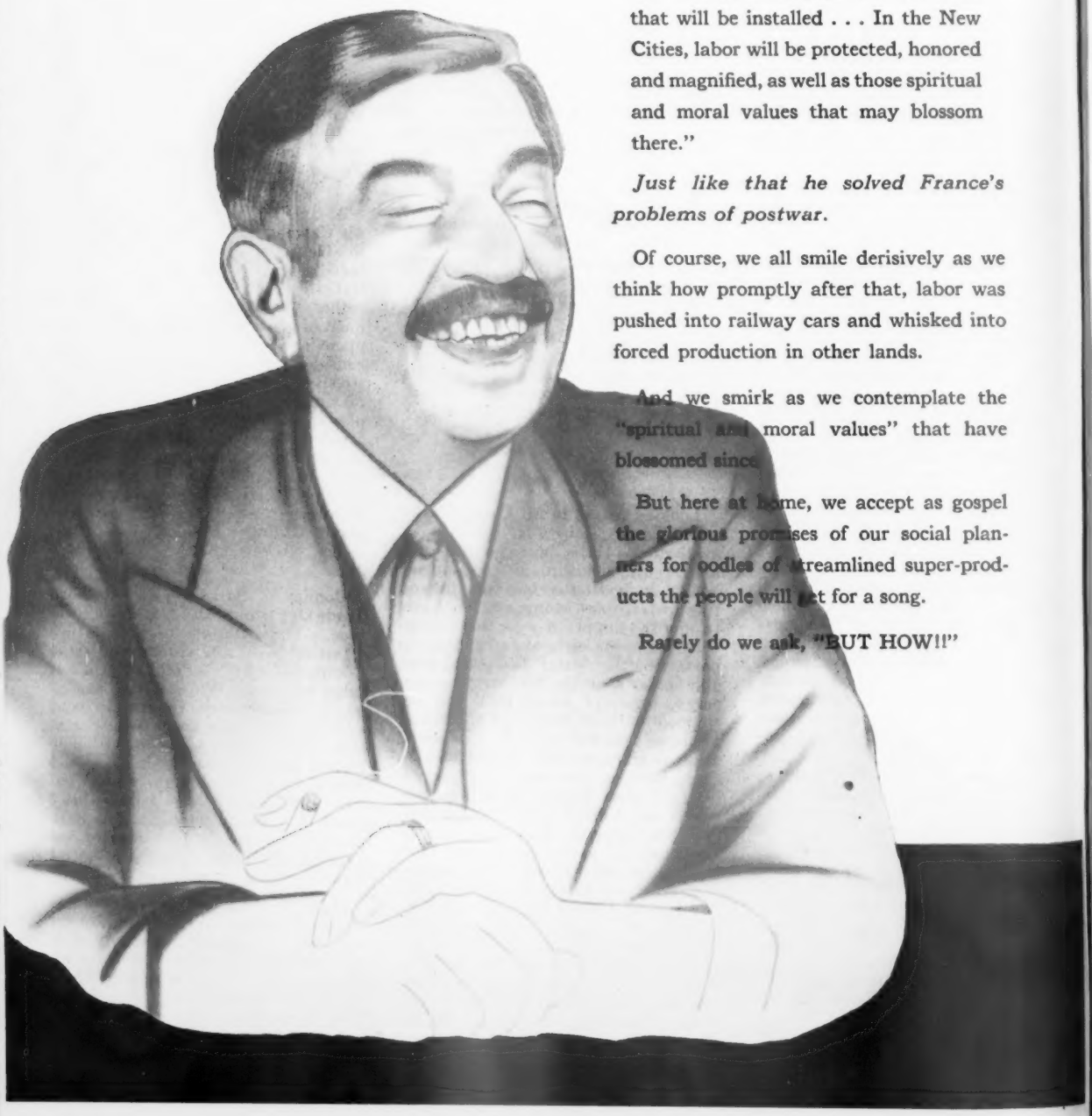
A Unit Load Transfer System for Air Cargo. C. W. Gordon. In order to facilitate air-cargo service and speed, a plan is proposed for a centralized city air-cargo terminal, together with methods for the movement of loads from the terminal to the plane and vice versa. Taking into consideration the variety of package sizes and shapes which hinder the maximum air-shipment efficiency, the plan is based upon the arrangement of articles for unit loading, unloading, and stowing. The main points of the plan are outlined under four headings: terminal location, terminal operation, highway transfer of unit loads, and plane loading. *Flying*, May, 1944, pages AC-10–AC-12, AC-21, 3 illus.

Coming: Paradise of Air-Born Trade Opportunities. J. Stanton Robbins. The writer discusses the future of air-cargo in inter-American trade. Comparisons are made of the time it takes to transport cargo between various points in South America by land and by air. How poor transportation affects prices is discussed. The cost of building airports is compared with the cost of building roads. Mention is made of the commodities South American merchants are shipping by plane. *Air Transportation*, April, 1944, pages 36–41, 4 illus.

How to Expedite Shipments by Proper Labeling. As indicated by Air Service Command reports, advice is given on how to label shipments for air transport. The suggestions come under the headings of how to mark, what to mark with, what to mark on, and what to mark. A chart tabulates the procedures for Army air shipments. *Flying*, May, 1944, page AC-13.

then he said to himself

"I hope they don't ask me HOW!"



Pierre Laval, on being handed the mouthpiece by Adolf, promptly broadcast to the French people:

"In the New Europe, it is socialism that will be installed . . . In the New Cities, labor will be protected, honored and magnified, as well as those spiritual and moral values that may blossom there."

Just like that he solved France's problems of postwar.

Of course, we all smile derisively as we think how promptly after that, labor was pushed into railway cars and whisked into forced production in other lands.

And we smirk as we contemplate the "spiritual and moral values" that have blossomed since.

But here at home, we accept as gospel the glorious promises of our social planners for oodles of streamlined super-products the people will get for a song.

Rarely do we ask, "BUT HOW!!"

"Protected, Honored and Magnified"—*he says*

Look, Pierre, under your own or any *new social order,* a small group of soft-handed *theorists* like yourself could never give a *practical* answer to the challenge: "BUT HOW?" Yet under an old American *free enterprise* system . . . where protection, honor and magnification are in every man's grasp—*workmen* down in most metal working plants can themselves answer: *HERE'S HOW!!* (How to get MORE products. — How to get BETTER products. — How to get products AT A LOWER COST —so that more people can *afford* to buy).

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Air Power

Air-Warfare Review. Hanson W. Baldwin. Several reasons for the increasing success of the Allied bombardment campaign against Germany are discussed, while other developments that may limit the effectiveness of the bombing attacks are pointed out. The limiting developments under consideration are counterattacks by the Germans upon England, in which thousands of tin-foil strips were used to jam the British radar and hinder interception; the diversion of part of the Allied bomber forces to "rocket-gun" installations along the coast of northern France; and the publicized "secret weapon," the rocket-bomb. The factors in favor of the Allies which are discussed are the great increase in American air strength based in Britain; the use of a new navigational bombing technique permitting bombing through dense cloud layers; and the employment of large groups of long-range fighters, using detachable gas tanks, to protect Allied bombers.

Summarizing the effects of strategic bombardment on Germany as being similar to those of blockade, this air-news review also comments briefly upon the role played by air power on other fronts during the early months of 1944. *Skyways*, May, 1944, pages 9, 70, 1 illus.

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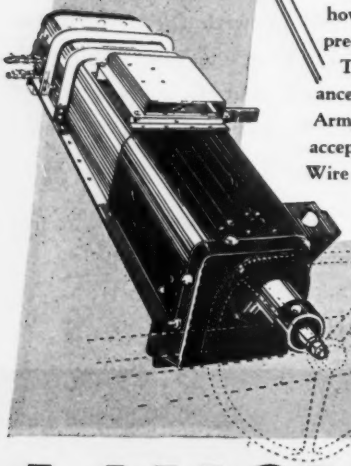

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Air Strategy in the Pacific. Brig. Gen. Henry J. Reilly. The writer claims that Allied victory in the Pacific must be based on combined operations carried out under a single command. Reviewing Japan's record of systematically acquiring Pacific island bases and the United States' failure to follow such a policy in the past, he shows why the military conquest of such bases is the first requisite for the employment of adequate air power, as well as the necessary naval and land forces. He also explains why the great distances between bases and countries in the Pacific area require an air strategy different from the independent air attacks made by the Allied air forces in the European theater of war.

Indicating the limitations of a number of alternate routes to Japan, the writer concludes that, without the use of Siberia, the most feasible conquest pattern for the Allies in the Far East is to continue to capture Japanese islands and use them as air bases from which to launch attacks on the next group of islands. He states that the indicated line of march would be to recapture the Philippines, after restoring the old route from the United States' west coast via Hawaii, Wake, and Guam, and then take the bases now held by Japan in the Marshall, Caroline, Marianas, and Palau islands. This would give the Allies a broad band of island positions across the Pacific from which to operate and would also cut off the Japanese from their resources in the Dutch East Indies. *Flying*, May, 1944, pages 21-23, 102, 104, 108, 3 illus.

The Czechoslovak Air Force. Air Vice-Marshal K. Janousek. As recorded in an interview, the Inspector-General of the Czechoslovakian air force reports on the status of his country's air strength at the time of the Munich episode. He reviews the activities of Czechoslovakian air crews since the beginning of the war, and makes several predictions as to the future of Czechoslovakian aviation. The performance of Czechoslovakian fliers in the war is traced. Their air operations in France, the reorganization of the Czechoslovak Air Force in Great Britain, and the formation and exploits of fighter squadrons and bomber units are reviewed. Expressing sympathy with "Freedom-of-the-Air" views, the Air Vice-Marshal states his country's interest in specific postwar aviation problems, such as transport policies, progress in radio technique, and development of telecommunication service. He also offers the opinion that Germany and her satellites must be excluded definitely from any participation in postwar civilian aviation. *The Aeroplane*, March 31, 1944, pages 362, 363, 4 illus.

Air Transport

Global Air Transport and the Flying Boat's Role. Capt. C. H. Schildhauer. Some observations on postwar global air routes and the types of aircraft that will

For war today...for all flyers tomorrow!

EVEN the best grades of aviation gasoline generally available only a few years ago wouldn't be worth a hoot to a modern plane in combat.

In fact, the performance of the mighty engines of these planes is only made possible by development of an entirely new fuel.

You know it as "100-octane aviation gas." But it is actually considerably higher in performance value—a true super-fuel and super-difficult to make.

Yet oceans of this new super-fuel *are* being made, right now. Every refinery shown here is doing its part. So far in the war, *one in every four* British and American combat planes has flown on aviation fuel from these refineries.

Known as "fluid catalytic cracking units," they are designed around special processes developed by Esso. What they do to petroleum sounds almost like magic even to an oil chemist.

It is simple truth that no process or company in the world, so far as we know, has ever surpassed the products these plants can turn out.

Today, of course, this wonderful new fuel must all go to war. But when the war is over, these new plants will still be here—your guarantee of the finest fuels in human history for your post-war planes!

THE FIRST "E" AWARDED TO PETROLEUM RESEARCH WORKERS was made to Esso Laboratories, Bayway, N. J.

(THIS MESSAGE HAS BEEN REVIEWED IN FULL BY THE ARMY AND NAVY, WHICH HAVE NO OBJECTION TO ITS PUBLICATION)

BEGINNING

OF A

BOMB RUN

The bombing mission heading for the run over the target started back in the Hayes plant where the planes' wheels are made.

EVERY U. S. 4-ENGINE BOMBER is equipped with HAYES Wheels and Expander Tube Brakes. Medium bombers and fighter escorts by the hundreds also "start upstairs" on Hayes equipment.

Take-offs under combat conditions, and landings—whether shooting one landing or dozens daily—depend on the sound design and skilled manufacture of the Hayes organization.

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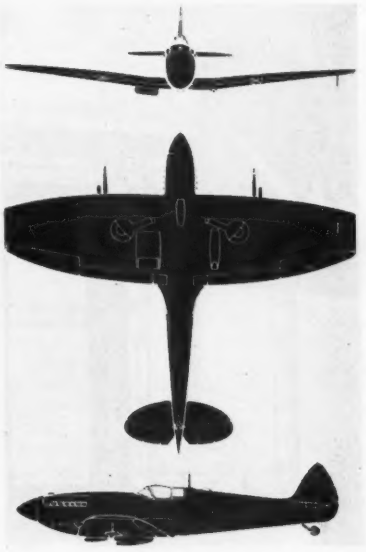
fly them. The writer claims that, because most commercial activities are conducted in the temperate zones, global air circuits will be located there rather than in the polar regions, despite the shorter distance of the polar routes. He also endeavors to prove that high pay-load factors inherent in flying boats dictate their use for long-haul, global air transport in preference to landplanes. His estimated location of future global air circuits is shown on an accompanying map.

Reviewing technical and meteorologic obstacles to polar routes, the writer stresses two economic obstacles that can be added to these: one, that there is no business along the way; and the other, that the run, with or without refueling stations, will be expensive to maintain. With regard to equipment for global operations, he compares flying boats and landplanes on points of efficiency, speed, performance, and facilities required.

Comments are also made on the question of the United States' global air-line policy. Subsidies are viewed adversely. It is stated that the State Department should be the sole agency to obtain operating privileges in foreign lands and that such privileges should not be limited as to companies or number of stops. *Aviation*, April, 1944, pages 112–115, 283–287, 5 illus.

Governing Principles for Expansion of U. S. Airline System. Lewis C. Sorrel. In a report prepared for the Air Transport Association and filed with the Civil Aeronautics Board, broad underlying principles are outlined for the development and control of air transportation on a national scale under government supervision. In the first of three sections it is contrasted with the history of the growth of older types of land transportation under private enterprise and competitive conditions. It is noted that the major mistakes of railroad promotion were the spasmodic rate of development, the local initiation and control of much of the growth, and the intensely speculative motivation. Many of the troubles of the railroads are attributed to these mistakes but it is stated that, in view of the circumstances surrounding their establishment in an expanding new nation, the process probably could not have been arranged otherwise. Advice is given to the effect that the lessons of the past should be applied to avoid similar errors in the development of a new industry. These are: (1) Plan for future growth, but do not force the rate faster than real public need requires; promote wisely, as if in terms of an investment of money. (2) Plan nationally and flexibly in order to test individual and community proposals by their conformity or nonconformity therewith. (3) Adhere to prior planning to avoid defects; do not assume that major defects can be corrected after vested interests have grown up about them. Supplementing this plan with advice as to how it can be carried out, the writer quotes statistics on passenger, mail, and express service by air, and surveys the prospects for the establishment of gateway cities and routes. *Air Transport*, April, 1944, pages 20–23, 5 illus.



The Spitfire Mark XII low-altitude single-seater fighter. The plane has a span of 32 ft. 2 in. and a length of 30 ft. 9 in. It may be recognized by the following features: Low wing; in-line engine; long pointed nose; wings have dihedral from roots and are elliptical in plan with square-cut tips; radiator under starboard wing; slender streamlined fuselage; elliptical tailplane with "V" cutout; small curved single fin and rudder with pointed top and fairing to fuselage. This new version is powered by the Rolls-Royce 1,500-hp. Griffon engine.

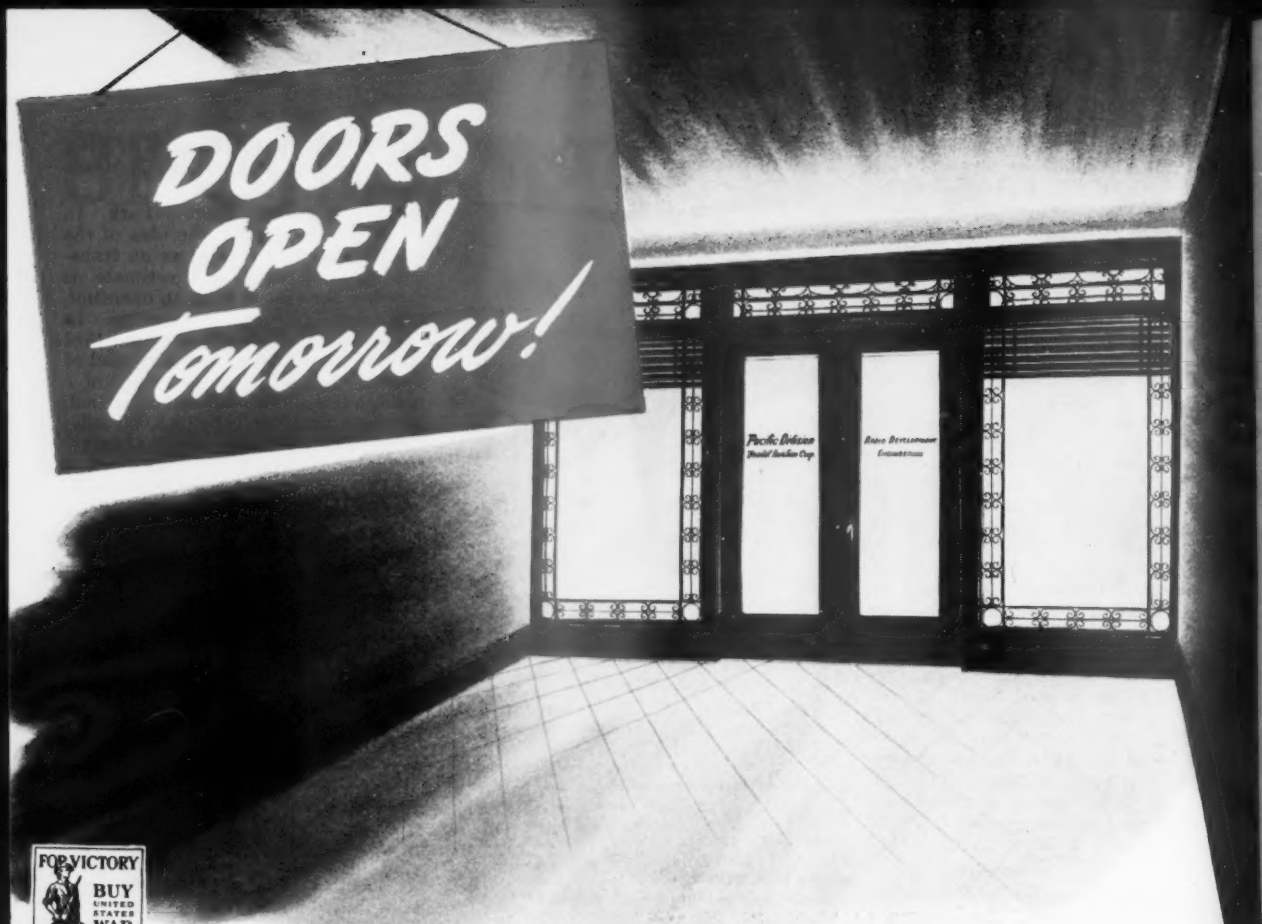
Plan for High Altitude Transport of Perishables. Part II. Charles E. Planck. The second of two articles describing a plan for refrigeration of perishable cargoes during air transportation. The principles of the proposed in-flight refrigerating method were outlined in Part I. Part II is concerned with the economics of its operation in competition with surface transportation. Consideration is given to the comparative costs of both methods of freighting, the additional advantages offered by the speed of air transportation, costs of equipment for the various means of transportation, and the operational costs of present "ground" systems for freezing perishables. As the most common product requiring refrigeration during transportation, foodstuffs receive principal attention in the discussion of commodity movement. The data contained in the article include mention of the types of aircraft suitable for the refrigerating-during-transportation operation and are based on information offered by the developer of the idea, Harry W. Protzeller. Supplementary tables and charts illustrate cost vs. distance in commodity movement, comparative refrigeration-equipment costs, distribution of seasons for perishable foods, present concentration of freezing plants and major markets, and air conditions at various altitudes. *Flying*, May, 1944, pages AC-16, AC-17, AC-22, 3 illus.

Airfields at Sea. Allen S. Park. In an article elaborating the idea of the establishment of seadromes on transoceanic air routes, an estimate is given of the cost of such an operation and of the prospective earnings. In support of the idea, it is stated that for a flight of 900 miles a pay load of 20 per cent of the gross weight of a modern transport plane can be carried, but for a nonstop flight of 3,600 miles the pay load drops to 4 per cent because of the added fuel load. A description of the proposed seadrome is given, quoting previously published information regarding methods of operation and the theories on which the design is based. It is noted that Pennsylvania-Central Air Lines has filed an application with the Civil Aeronautics Administration for a transatlantic route using seadromes at stated intervals. An estimate made by the inventor of the seadrome, Edward P. Armstrong, shows gross annual receipts of $6,000,000 from airplane toll charges, fuel-sale profits, hotel and store rentals, and miscellaneous income. Operating expenses are estimated at $1,700,000, amortization at $1,875,000, and indicated profit at $2,245,000. The estimated gross income has been halved for the first year, and an average gross of $15,000,000—a substantial profit—is figured for future years. *The Draftsman*, April, 1944, pages 12–16, 43, 8 illus.

Two-Man Maintenance. Oscar Leiding. The second of two articles describing a "one-man" air line being operated between Port Clinton, O., and four islands in Lake Erie. Maintenance operations that make possible year-round service are outlined. The simple maintenance department is described. Modifications made in the original Ford trimotor planes to fit them for operation on the small and not-too-smooth landing fields are also described. *Air Transport*, April, 1944, pages 59, 60, 64, 67, 69, 7 illus.

Airplane Descriptions

The Vickers Warwick. Specifications and descriptive data are given on the Warwick, a transport type of aircraft developed from the Vickers Wellesley and Wellington. Like its predecessors, the Warwick is reported to be of geodetic construction. Its low-weight structure has the form of a wickerwork pattern of bracing members, each capable of taking both compression and tension loads, and so interconnected that the compression loads in one member are relieved to a considerable extent by the tension loads in other members. In addition to the Wellington's shape of streamlined fuselage, surmounted at the back by a tall fin, the Warwick is said to have the same tapered high-aspect ratio wings projecting unusually far beyond the two engine nacelles. A comparison between the original Wellington and the Warwick



New radio developments are being worked out behind these new doors. ¶ On the success of its past achievements Pacific Division's Radio Engineering Laboratory has earned for itself a greatly expanded workshop. ¶ The same engineers who developed the Gibson Girl Emergency Transmitter . . . who pioneered in radio remote control equipment, now have the full facilities to accelerate their development work. Principally they are working on a new interpretation of simplified UHF for aircraft and other uses. The doors of this new laboratory will open tomorrow when this development is perfected.

Before Pearl Harbor Pacific Division developed the famous Gibson Girl Emergency Transmitter, which is now standard equipment on every A.A.F. and A.T.C. airplane making overwater flights.

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shows the latter to be a much larger aircraft. Two versions of the Pratt & Whitney R-2800 series are used in the Warwick, the S1A4-G and the 28B-G. The article does not include performance figures for the transport. *Flight*, March 30, 1944, pages 332, 333, 2 illus.

Invasion Assortment. Predicting that, as far as possible, only the finest weapons available will be used by invaders and defenders in the invasion of Germany, the writer proceeds to outline and compare recent Allied and enemy aircraft developments. Particular attention is given to details of enemy airplanes which have been learned in recent months. Various developments of the Focke-Wulf are discussed. The He 219, a new two-engine fighter-dive bomber and older types of German aircraft that may be resorted to for defense are mentioned.

The products of the French and Italian aircraft factories are discussed. It is noted that much of the French industry is repairing or producing German types, but that, instead of stopping the production of French Gnome-Rhone engines, the enemy equipped two leading types of planes with them. The He 129 was modified to take this French engine. It is stated that the recently attacked Marignane factory built the S. E. 200 six-engine flying boat and was engaged in modifying Liore-et-Olivier LeO 45 two-engine French bombers into troop transports. Other French aircraft that may be used include the Potez 63/11, Dewoitine D 520, Bloch 151-C1, Breguet 691, and the Morane-Saulnier MS 406 c. Italian aircraft mentioned include the Macchi MC 202, Fiat G 50, Caproni-Reggiane Re 2001, Meridionali Ro 57, and the Cant Z 1018. *The Aeroplane Spotter*, March 23, 1944, pages 64, 65, 6 illus.

Notes on Russian Equipment. P. H. C. Notes on three types of Russian aircraft—the MIG-3, YAK 1 and 3, and the LAGG 3—and their developments. Information also is given about Russian aircraft armament and some of the foreign aircraft used by the Russian Air Force. *Aeronautics*, April, 1944, pages 56, 57, 4 illus.

Aeroplanes of the Swedish Air Force. A list is given of the types of airplanes at present in operation with the Royal Swedish Air Force. This includes seven types of bombers; six of fighters; eight of reconnaissance, observation, and cooperation planes; one type of communications plane; two of transport and ambulance craft; and four of trainers. The designations and their modifications are given, as well as the names of the makers. Eight of the types are illustrated, with condensed specifications comprising type and manufacturer, duty, engine, dimensions, weight, and performance. The Swedish airplane industry is described as consisting of two parts: the government aircraft factories and two private manufacturing companies. Several airplane types in use are of British, German, and Italian design, manufactured in Sweden under license. In several cases American engines are used. *The Aeroplane Spotter*, April 6, 1944, pages 76, 77, 8 illus.

Airports and Airfields

Flight Strips. Some general notes on the construction and utility of flight strips. Types of flight strips, their wartime applications, the selection of present sites, and maintenance are discussed. Pertinent to the postwar potentialities of flight strips, mention is made of their probable development by petroleum companies and the possibilities in their use for air-mail pickup service. *Air News*, April, 1944, pages 22, 23, 64, 5 illus.

The Airport Terminal Problem. Albert F. Heino. Details are given on a suggested scheme for an airport terminal that will be able to meet the expanding requirements of postwar air traffic. Although incorporating some advantages of the present method of concentrating all terminal activity in one location, the plan is based mainly on the decentralization idea, permitting the passengers, baggage, mail, and express for a given airplane to go directly to the airplane without passing through a central terminal building. It has as its nucleus a series of one-story units interconnected with each other and with the central public building. The development expands as a one-story group of buildings until such time as the traffic warrants a separation of passenger and cargo handling at different levels. In addition to the construction of such an airport, the article includes particulars on how it would function. Advantages of both the decentralization plan and the composite terminal are cited. *Commercial Aviation*, March, 1944, pages 48–54, 8 illus.

War Airdromes in the European Theater. George Stromme. An account of the airfields built in Britain by the United States Army Engineers for the use of the U.S.A.A.F. The article not only covers the planning and design of the airdromes, but also construction procedures, equipment, and materials; the design and building of hangars, control towers, and living quarters for the personnel; methods of maintaining and repairing the airfields; and the problems involved in their disposal after the war. In the description of construction procedures and equipment, particulars are given with regard to the following machines: bulldozers, carryalls, turnapulls, the Barber Greene ditcher or trencher, the Multi-Foote paver 34E, a revolving drum mixer, and the Blaw-Knox XB-5 finisher. Comments are also included on the nature of the terrain, the time it takes to construct an operational field, costs, and camouflage.

Four factors are noted as having been particularly helpful in facilitating the quantity production of American airdromes in Britain. These are: (1) English soil is almost universally the same fine clay, and does not require any other than "standardized" processing. (2) Prevailing winds over the British Isles are northeast to southwest and, since 95 per cent of all winds blow at less than 35 m.p.h., main runways could be standardized in direction. (3) Altitude and barometric pressures were equally stable throughout the land under consideration. (4) The Royal Air Force's "bomber standard" airdrome design was discovered to be completely adequate for all American needs—fighter fields, service depots, and bomber bases. *Western Flying*, April, 1944, pages 212, 214, 216, 218, 220, 222, 224, 9 illus.

25,000 Landing Fields? Charles E. Planck. The suggestion is made that after the war farmers should establish small airports on their land, as a profitable alternative to raising crops. The writer indicates specifications for such airports and discusses the means by which farmers could derive income from them through the establishment of supplementary services such as tourist cabins and hotels, restaurants, hangars, gas and oil stations, etc. Comparing the income that may be derived by the farmers from such ventures with the average income gained from crops, he also considers the impetus that the establishment of many small, conveniently located airports will give to private flying. In order to investigate the feasibility of the proposed plan, the writer further suggests that the aeronautics departments of State universities institute "small airports" studies and make them laboratory projects for several departments of the universities. He demonstrates the aspects of the study which would be of interest to the departments of agriculture, aeronautics, law, engineering, architecture, and journalism. *Southern Flight*, April, 1944, pages 30, 31.

Landing Strips Can Pay Their Way. Russ Brinkley. Flight strips are advocated as the answer to nonself-supporting airports. It is shown how facilities alongside these strips can be developed to serve both motorists and fliers, turning the landing strip projects into profitable enterprises. The feasibility of substituting flight strips for all-way fields are also discussed from the points of convenience, adequacy, economy of construction, reduction of traffic-control problems, etc. While noting that landing strips have the disadvantage of not always permitting landings and take-offs into the wind, the writer indicates how this obstacle can be overcome. Specifications for the proposed strips are outlined. *Air Pilot and Technician*, April, 1944, pages 12, 13, 35, 1 illus.

Straw Mulch Lays Dust Around a Desert Airfield. A brief item describes how a mulch of straw partly disced into the surface has proved

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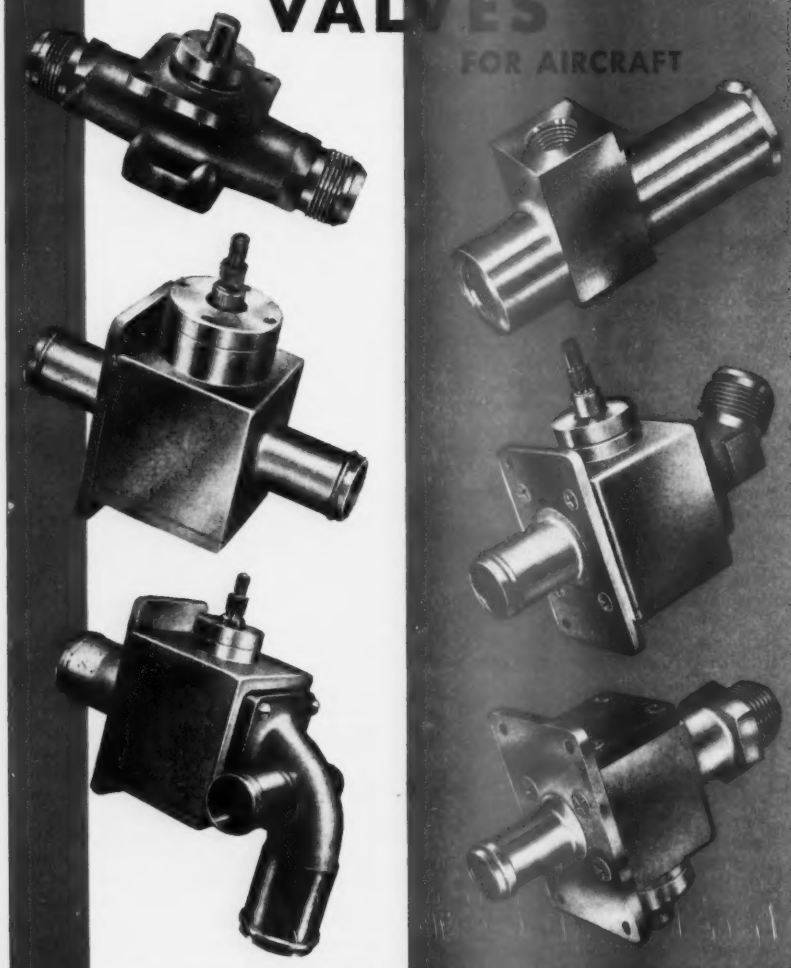

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successful in the control of dust from the sandy wastes surrounding the runways of a desert airfield. *Engineering News-Record*, April 6, 1944, page 75, 2 illus.

Bituminous Airport Runways. This article gives instructions for the maintenance of the runways and other pavements of airports where the paving material is asphalt. To provide a better appreciation of proper runway maintenance, an outline is given of the design of, and specifications for, asphalt pavements for airports. Maintenance methods and procedures recommended by the Asphalt Institute are considered, as well as the practices suggested by that organization. The subject is dealt with in sections devoted to types of asphalt construction, asphalt macadam, surface maintenance, surface treatment, the breaking of edges, road mixes, hot surfaces, check cracking, nonbituminous surfaces, and resurfacing. *Aviation Maintenance*, May, 1944, pages 47–50, 154, 156, 158, 10 illus.

Builders Urged to Study Airport Design. E. J. Foley. In this article it is urged that some established building-contracting firm contribute to the future of aviation by making a thorough study of airport design and the problems involved. The value of such a study is discussed and some of the problems to be solved are mentioned. *American Aviation*, April 15, 1944, page 68.

Wilderness Airport. Mary Ellen Leary. The story of Otis Lodge Airport. Indicated as an example of the practical applications of private flying and the type of small airport needed for it, an account is given of how one man in northern Minnesota successfully combined a vacation resort with an airport. Biographic data on the owner of the "airplane tourist camp," Arthur Otis, are included. *The Saturday Evening Post*, April 15, 1944, pages 26, 27, 37, 39, 6 illus.

Making One Runway Do. A discussion of how employment of the Maclaren drift undercarriage on civil aircraft can lead to a more economical type of airport construction after the war. Indicating the costliness of multiple runways, the article explains the construction and operation of the Maclaren device, which makes only one runway sufficient for certain airports. As described, the basic idea of the drift undercarriage is that the wheels can be set at the angle of drift. Therefore, the wheels remain parallel to the flight path, even though the aircraft may "crab." *Flight*, March 16, 1944, pages 291, 292, 3 illus.; "Landing Problems," *The Aeroplane*, March 24, 1944, page 318, 2 illus.; "Airport Space Needs," *Modern Transport*, April 1, 1944, page 7, 2 illus.

Armament

Steeled for Flak. A survey of development trends in aircraft armor protection. Among the developments noted are bullet-sealing tanks and

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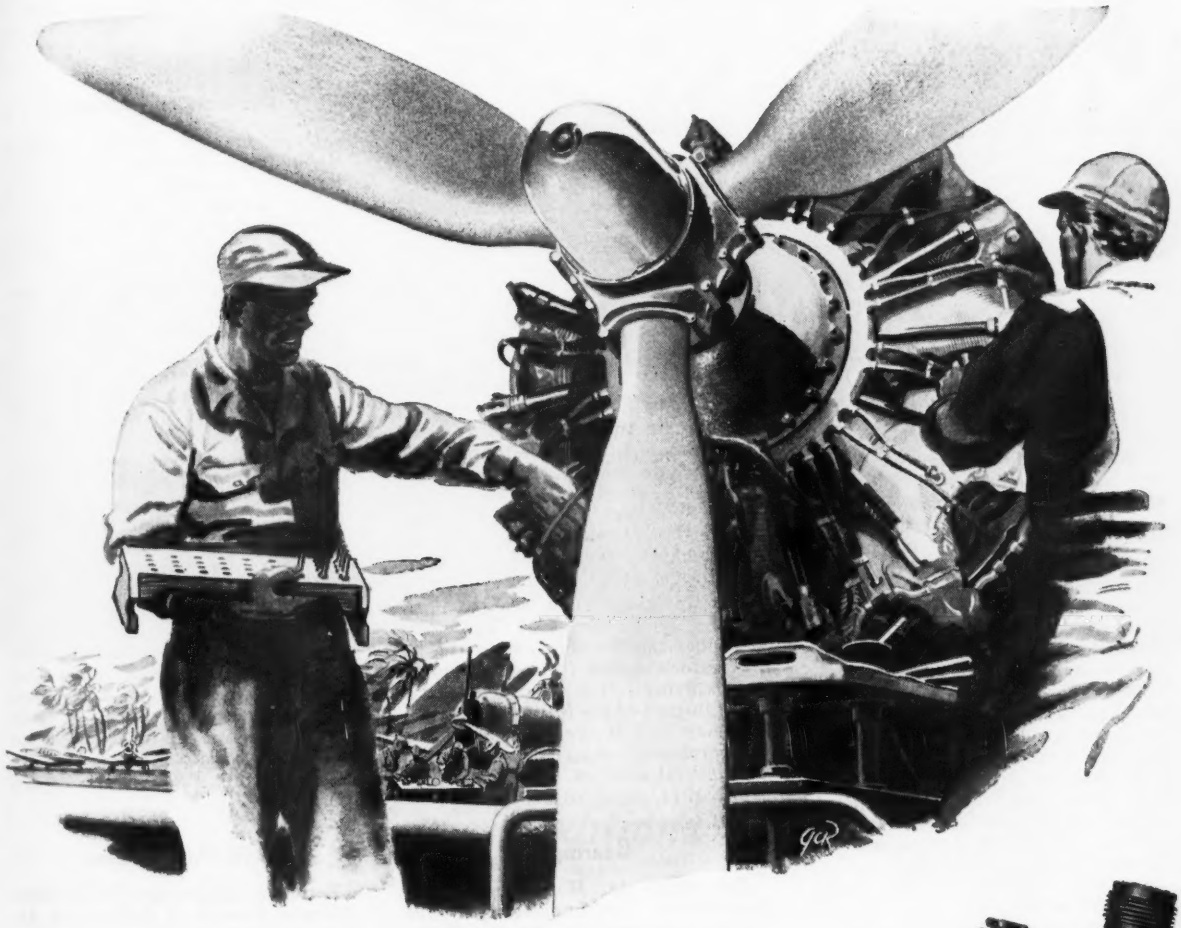

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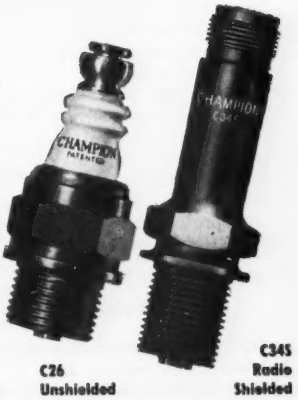

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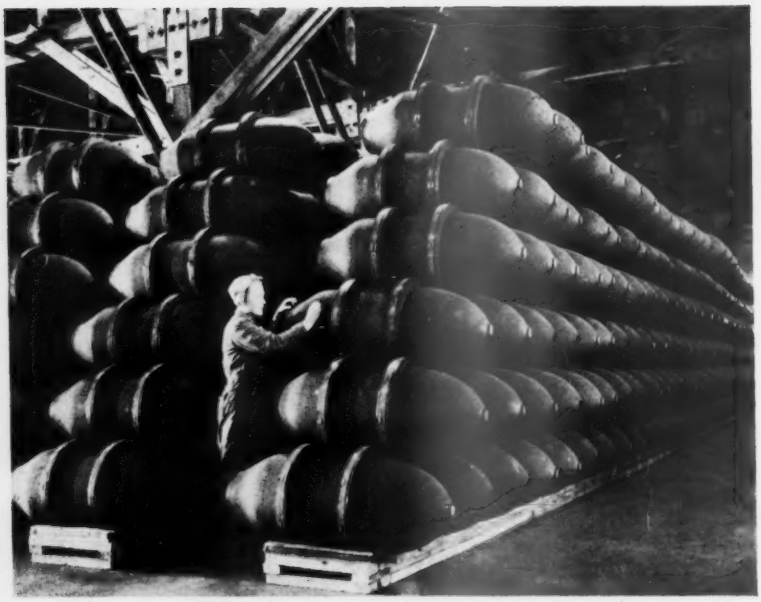

Rows of 1,000-lb. bomb cases, prior to being charged with explosives, at a Firestone Tire & Rubber Company plant.

synthetic-rubber coatings for them, incendiary bullets that will fire such tanks, local armor protection around gunners and gun positions, and headgear for reducing head injuries. Indicating the difference between homogeneous and face hardened armor plate, the article describes the characteristics and qualities of the latter which make it particularly adaptable for aircraft protection. With regard to the immediate future of airplane armored defense, it is stated that pilots, bombardiers, and navigators are being given added protection despite increase in weight. Gunners will gradually be concentrated away from gun positions and turrets, which will be remote controlled. The concentration will allow centralized construction and control of equipment, oxygen supply, and armor plating. Pending the invention of super-resistant plate, the use of carefully placed plates will be continued. Baffling will be improved, several layers of thin sections of different structure being superimposed on each other.

For the more distant future two possibilities are noted: (1) Pilots or crews of warplanes will be completely enclosed in armored structures, with only direct hits by shells of the heaviest caliber able to damage either the armored cabin or the aircraft structure. (2) Future military craft may be completely remote-controlled and not carry any human beings, thus requiring no new armor-protection inventions. *Air News*, April, 1944, pages 28–30, 12 illus.

Avigation

Mr. Magellan—Class of '44. Pat Curtin. The ancient history of navigation is traced in this article and the story is brought up to date with a description of some of the problems faced by the air navigator today. Present-day navigation instruments are compared with those used in earlier times. *Air Transport*, April, 1944, pages 25–28, 6 illus.

Alternate Airport Adventure. Larry J. Fischer. An elementary treatment of alternate airport problems. The student is given step-by-step advice for working out the solutions. Suggestions for plotting graphic solutions are included. *Southern Flight*, April, 1944, pages 34, 35, 50, 9 illus.

Air Navigator—The '30s and Postwar. Peter H. Redpath. The writer describes the development of the air navigator's duties from the time he enters flying. It is suggested that in air transport of the future the navigator may find it useful to become a meteorologist, especially for intercontinental services. *Air Transport*, April, 1944, pages 28–31, 5 illus.

Bearings

Zur Frage der Herstellung hochbelastbarer Verbundgleitlager für Verbrennungsmotore (On the Problem of Producing Compound Bearings, Which Have a High Stress-Resisting Quality, for Internal-Combustion Engines). F. Bollenrath and W. Siedenburg. It is stated that the most important factors for the formation of the proper structure of lead-bronze melts are measures for their gasification and cooling conditions after casting. Compound lead-bronze bearings, which had been cooled under various conditions, were tested metallographically and by means of X-rays. The relation between thickness of the casting, structure, and loadability is determined. Research on the production of bearing-metal layers of copper-lead alloys, silver-lead alloys, and silver by means of the electrolytic method is mentioned, and results of load tests are presented. *Luftfahrtforschung*, December 8, 1943, pages 269–279, 28 illus.

Herstellung von Bleibronze-Verbundlagern durch elektrisch-induktive Erhitzung (Production of Lead-Bronze Compound Bearings by Means of Electric Induction Heating). F. Bollenrath and W. Siedenburg. This report gives information about the construction of an experimental apparatus to produce lead-bronze bearings in steel bushings by means of electrically induced heat in combination with the centrifugal method. Results of tests on a bearing-testing machine are given. *Luftfahrtforschung*, December 8, 1943, pages 280–283, 7 illus.

Business and Finance

Hope for the Aircraft Investor. Raymond L. Hoadley. Reasons are given why aircraft equities will probably be viewed with more favor in the immediate future than they have been for some time in the past. In general, the predicted rise is attributed to the fact that definite steps have been taken for the reconversion of industry after the war, with praise accorded to the Baruch program and the George Senate Committee. Specifically, the reasons include the following: assurance that the transition period will not be prolonged unnecessarily; program provisions for liquidation of surplus equipment and protection of the working capital position of the aircraft industry; the probability that corporation taxes are as high as they are likely to go; expiration of renegotiation law at end of 1944; probable settlement of the excess-plant problem; decreasing likelihood of automotive manufacturers staying in the aircraft business; plans of aircraft companies to enter new fields; Congressional appropriations for postwar military planes; and the fact that the aircraft industry will be about the last to reconvert back to peacetime products. *Aviation*, April, 1944, pages 119, 263, 265, 1 illus.

Civil Air Defense

Fernsteuerungen der Flakartillerie (Remote Control of Antiaircraft Artillery). H. Hopf. In a study of remote-control equipment for antiaircraft artillery, it is stated that in case aiming by hand cannot be done rapidly enough and with sufficient accuracy it becomes necessary to couple a remote-control system and a data transmitter between the control instrument and the more or less distant guns or searchlights within its range. The control instrument consists of either a stereoscopic fire director or a sound locator. Various possibilities of remote control for antiaircraft artillery are discussed, and several types of remote-control systems are described. *Zeitschrift des Vereines Deutscher Ingenieure*, December 11, 1943, pages 785–790, 15 illus.

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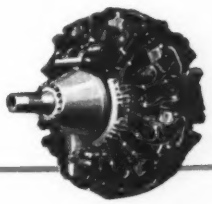

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Civil Aviation

Re: Forced Landings. Lt. Arthur J. Schuck. An article discussing the legal responsibilities arising from the ownership of an aircraft. It is stated that, in general, these risks are similar to those arising from the ownership of an automobile and are insurable.

From a legal standpoint, the risks are somewhat greater because in some cases liability is absolute and not dependent in any way on the fault of the owner or pilot. From a practical standpoint, they may be somewhat less to date because aircraft, not being confined, are not so concentrated as automobiles, which must of course follow established roads.

It is recommended that all pilots strive (1) for the adoption of suitable legislation in each state to determine their rights and (2) for the reduction of premiums on aircraft liability insurance so as to spread the risk among as large a percentage of those who fly as possible. *Aviation and Yachting*, April, 1944, pages 8, 9, 1 illus.

Companies

The Story of Western Air Lines. Midge Winters. Western Air Lines' 18 years of operations are reviewed. Included in the brief history are data on the company's equipment, routes, mileage, schedules, executives, profits, and revenues. *Airlanes*, April, 1944, pages 10, 11, 20, 4 illus.

Control Equipment

The Electronic Airplane. S. R. Winters. The use of the electronic tube in aviation is discussed. It is stated that airplanes operated solely by electronics (without pilots) are a future probability. The writer notes that the nearest realistic approach to the operation of an airplane without the human element is an invention of three Government engineers whereby an electric eye, or photoelectric cell, controls the rate of climb or descent of a plane. Features of the invention are described and other electronic developments in aviation are outlined. *Aircraft Age*, June, 1944, pages 26, 27, 61, 62, 4 illus.

Design

Experimental Determination of Hull Displacement. Ernest G. Stout. Methods for estimating the static displacement, trim, waterline, and center of buoyancy for flying-boat hulls are discussed. Principles and procedures used in naval architecture and shipbuilding have been found inadequate for seaplane hull design because of the number and intricacy of solutions necessary for the varying conditions. A simple and direct experimental procedure is suggested which, with reasonable care, is stated to be better than classic computations and to involve less risk of error.

This involves the construction of a displacement model based on established principles of hydrodynamics and made as an accurate scale model of the hull. A typical displacement model of this type is fully described, illustrated, and diagrammed, with an explanation of its construction and use in connection with a trimming basin and the necessary auxiliary equipment. The experimental testing procedure, including the related mathematical computations, charts, and tables, is outlined. The results are analyzed and their application to changes in the design are explained. *Aviation*, April, 1944, pages 121–125, 277, 279, 281, 283, 8 illus.

Effect of Overload and Unbalance on Long Range Aircraft Operation. James B. Childers. Overloading of aircraft and its effect on long-range operation is discussed. The object is to give information about the fundamental theory involved and to show the serious results of overloading within the ranges of modern airplanes. An effort is made to avoid aerodynamic and mathematical analysis of the variations of range with weight and the effects of altitude and temperature, the calculations being based on sea-level conditions. The relationship of lift and drag are explained in simplified terms, and other factors, including the propulsive efficiency, power coefficient, and fuel consumption, are treated in similar manner. The method of combining the various terms and factors to obtain the range of any airplane is developed without the complex mathematics used in range calculations by aerodynamicists. Range charts and their use are explained. It is concluded that weight is the most critical factor, and that any extra load, in excess of the critical gross weight, should not be imposed. *Aero Digest*, April 15, 1944, pages 88, 90, 91, 7 illus.

Levered Suspension. R. H. Bound. Problems connected with the design of retracting undercarriages are outlined. It is stated that an analysis of the telescopic compression leg, which has been in popular use for many years, reveals certain deficiencies inherent in the system.

These deficiencies are described, and it is then stated that levered suspension has proved a practical solution to the problem. The principle of levered suspension is explained and the advantages of the method are outlined. Illustrations show levered-suspension undercarriages for a bomber and a fighter, and a levered-suspension nose wheel with a tension shock absorber. The telescopic undercarriage for heavy aircraft is also described and illustrated. *Flight*, March 30, 1944, pages 345, 346, 5 illus.

American Aircraft 1944. A brief view of a year's progress in aeronautical engineering, as indicated by improvements in American warplanes from the spring of 1943 to the spring of 1944. In general, it is reported, there has been a trend toward more and heavier bombers, larger cargo planes, higher engine horsepower, greater range, and more fire power. Among the more specific contributions toward design progress that are noted are those in connection with the P-38, P-47, P-51, P-61, B-17, B-24, B-25, B-26, B-29, the Corsair, and the Hellcat. Attention is also called to the Anglo-American development of jet-propelled planes. *Western Flying*, April, 1944, pages 66–68, 226, 8 illus.

Vibrations in Aircraft. Part II. R. G. Manley. The second of a series of articles about the general principles of vibration in aircraft. The subject of resonances in a complex system is considered. The writer discusses modes of vibration of a heavy bar, torsional engine vibration, and flexural propeller vibration. Dynamic stiffness curves for an engine-propeller system are shown. *Aircraft Engineering*, March, 1944, pages 73–75, 4 illus.

Key Considerations in Pressurized-Cabin Design. David B. Thurston. The purpose of this article is to outline some of the features present in any design for pressurized aircraft cabins and to demonstrate design methods that have proved successful in existing structures. Comparisons are made between the spherical and cylindrical types of structures and between the integral unit and the separate unit; the advantages of each type are shown. Means for sealing openings such as windows, doors, and similar outlets for controls and connections are discussed. Other factors discussed at considerable length are frost preventives, insulation, pressurizing equipment, relief valves, and compressors. The various methods of calculating the installation and operation of such equipment are shown by the use of formulas and tabulated data. A practical problem is stated and its solution is indicated. *Aviation*, April, 1944, pages 126–129, 255, 257, 258, 261, 7 illus.

High Performance Fighters. Kurt Tank. Problems of fighter plane design are considered by the designer of the Focke-Wulf FW 190 in an article taken from *Luftwissen*. Particular attention is given to problems connected with the designing of fighters for high-altitude operation, which include the problem of wing loading.

It is noted that fighter-design requirements call for maximum horizontal speed at altitude, maximum rate of climb and ceiling, maneuverability and driving power, combined in the smallest and lightest airplane possible. In addition to measures for increasing the high-altitude performance of the power unit, the design of the air frame must be based essentially on a regular theory of "high-altitude aerodynamics," giving proper consideration to the factors of weight and wing loading,

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etc., which begin to predominate at great heights. It will not always be possible, however, to combine these requisites of high horizontal speed, rate of climb, and ceiling in a single fighter at all heights. The universal, high-performance type to which modern fighter design is tending, therefore, becomes divided into two variants, differing in type of power unit (e.g., supercharger equipment), wing loading and aspect ratio, and design of propeller. *Automotive and Aviation Industries*, April 1, 1944, pages 22, 23, 56, 58, 4 illus.

Stressed Cellular Construction for Aeroplanes. J. W. Taylor. A suggested system is outlined for building an air frame of cellular construction, made almost entirely from pressed parts. The advantages of such a structure are demonstrated. With the same manufacturing methods employed for each part, the wing, tailplane, fin, rudder, elevator, and aileron chord all consist of standard sheets of metal suitably die-pressed for the cellular formation. A number of the sections are put together to build up the span of the airfoil and are attached by butt and strap joints in the intercellular spaces. The top and bottom airfoil surfaces are then attached together at the bases of the cells. This is followed by the insertion of a standard drawn section, conforming to the shape of the cells, which serves to make the airfoil stiff spanwise. The sections are attached by special means, which are explained in the article. The fuselage consists of an inner shell pressed to the cellular formation, the open ends of the cells being inboard. Diagrams help to illustrate the suggested construction. *The Aeroplane*, May 10, 1944, page 278, 3 illus.

The Flying Boat. W. P. Kemp. One of a series of articles on the comparative merits of the flying boat as opposed to the landplane. This article favors the flying boat and answers criticisms of the type made in a preceding article. Questions of forced landings, freight loading, lateral stability, and relative efficiency are discussed. *Flight*, March 30, 1944, pages 340a, 340b, 2 illus.

Fighter Design. M. A. Bugnon. The extent to which the individuality of designers has influenced the structural design of fighters is discussed. As examples of design individuality, the writer describes features of the Spitfire, P-51, Hurricane, FW 190, and P-39. Consideration is given to fuselage design, wing variation, girder construction, and other design features. *Air Tech*, April, 1944, pages 27–29, 76, 7 illus.

Analytic Geometry for Speedier Wing Lofting. Part II. R. W. Feeny. The second part of this study of methods for applying analytic geometry to the work of wing design takes up the problem of dealing with lines that are not necessarily parallel to any of the three coordinated axes planes. This problem includes the numerous control cables, hydraulic lines, stringers, spar

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

mold lines, and various hinge lines about which the control surfaces actuate. For these and the theoretical lines found in the wing itself, including the per-cent lines from which the contours of the normal and canted wing sections are determined, a method is offered for finding the equations of any line in space. An explanation is given of the method, with the aid of seven examples—each of which is worked out mathematically. The application of the demonstrated square-root method is explained in connection with the calculation of odd-shaped cover sheets or webs, such as a sheet to cover an area between the rear spar and the flap-closing channel and between a wing station and a canted station in a new combat airplane. In this case the canted station was a skewed rib, eliminating the possibility of triangulating the skin with the graphical method. The procedure is outlined and an example is given. It is shown that the work of designing the cover sheet was accomplished in a period of 1 to 2 hours. *Aviation*, April, 1944, pages 145–147, 291, 293, 295, 8 illus.

The Long Distance Cargo Aircraft. G. A. Mokrzycki. The author examines the problem of determining the best ratio of the weight of fuel to the pay load of the aircraft. This is considered to be a function of a design ratio of the disposable load to the gross weight. It is stated that the solution of this problem will enable the total load of the aircraft to be divided in the most economical manner between the weight of the fuel and the pay load. *The Quarterly Bulletin of the Polish Institute of Arts and Sciences in America*, January, 1944, 1 illus.

Messerschmitt Fighter Design. Devon Francis. The development of the Messerschmitt 109 series is traced from the initial version, introduced in 1936 during the Spanish Civil War, to the most recent model, the Me 109F6. Transitions in design and engine installations, as well as improvements in characteristics, are described; performance records are reviewed; and specifications are compared with those of the Spitfire. While giving the outstanding features of preceding models, the article contains a more detailed description of the Me 109G6. *Air News*, May, 1944, pages 26–29, 15 illus.

Electrical Equipment

Electrical Systems for Large Aircraft. Parts 1 and 2. W. K. Boice and L. G. Levoy, Jr. The first section of this article gives some of the considerations involved in the selection of electrical equipment for large aircraft and reviews the evolution from the 6-volt d.c. system. It describes the equipment in current use, operating at 24 to 30 volts, and mentions further developments involving 120-volt d.c. equipment and a.c. systems of frequencies ranging from 60 to 2,400 cycles. It is noted that experience with industrial and power-station apparatus provides a background for the study of aircraft systems, but indicates the many ways in which aircraft systems differ from electrical plants on land and advises that previous practice should not be followed too closely. The features that should be provided in the electrical system are outlined as follows: (1) maximum reliability under all conditions encountered in operation; (2) minimum weight; (3) minimum space requirements; (4) simplicity, including ease of operation, training and maintenance in field; (5) no (or, at least, little) interference by the system with the performance of the airplane or its equipment in any way; (6) satisfactory life of all component parts; (7) least cost in man-hours and dollars; (8) utilization of existing designs of aircraft accessory equipment as far as practical.

Means for driving generators and sources of auxiliary power are discussed, including auxiliary gasoline engines and the utilization of exhaust-gas energy. The various types of power systems are listed, with the numerous variations and combinations that can be employed to provide power for the operation of auxiliaries. Advantages of the low-voltage d.c. system are compared with those of 120-volt systems and those of higher voltages, for their particular class of service. The constant-frequency a.c. system is stated to be suitable for most loads but requires variable-ratio transmission and governors if it is to be operated from the main engines. Dual systems combining alternating current with direct current are also described.

Part 2 refers to the operating voltages and the factors that influence their selection. It is stated that the higher voltages are desirable because they minimize the weight of the power conductors, although the added weight of insulation tends to offset some of the saving. Cases in which alternating current is more desirable, as well as those where direct current has greater advantages, are mentioned, and advice is given about the selection of frequencies. High-speed motors are compared with geared types, reasons being given for the choice between single-phase and multiphase systems. Advice is also given about the proper type of generator to choose and how to obtain the source of power for excitation. Other matters considered are the grounding of the system, power-factor correction, paral-

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lel operation, synchronization, and grouping of electrical loads. Comments are added about the use of small independent, light-weight superchargers for use with auxiliary engines to drive the generators and about control equipment.

In conclusion, it is stated that the four probable voltage ranges for aircraft electrical systems will be as follows: 6- or 12-volt d.c. systems for small private planes; 27-volt d.c. for small and medium-sized planes; 27/120-volt d.c. for large, medium-altitude cargo or transport planes; 208/120-volt, three-phase, 400-cycle, a.c. for large, high-altitude, long-range planes. *Aero Digest*, March 1, 1944, pages 72, 73, 76, 228, 230, 5 illus.; April 15, 1944, pages 94, 96, 220, 222, 224, 228, 230, 232, 8 illus.; "Trend of Aircraft Electrical Power," Lt. Col. T. B. Holliday, *Industrial Aviation*, April, 1944, pages 17–19, 54, 4 illus.

Corona in Aircraft Electric Systems As a Function of Altitude. W. R. Wilson. It is noted that corona at operating voltages has often caused the rapid deterioration of the aircraft electric equipment in which it occurs. Corona-starting voltages of the components of a 208-volt, 400-cycle grounded-neutral electric system are reported for conditions to simulate altitudes between sea level and 50,000 ft. The corona characteristics are shown to be functions of air pressure, electric-field geometry, humidity, and the cleanliness of insulating surfaces. The effect of reducing pressure is shown to lower the corona-starting voltages of aircraft cables by as much as 60 per cent because the dielectric strength of large air gaps drops a comparable amount. Reducing the pressure has small effect on the corona-starting voltages of low-voltage capacitors, because the dielectric strength of small air gaps is nearly independent of pressure. Moisture and dust on insulating surfaces and moisture in aircraft cables produce corona-like disturbances below 208 volts. Information is given about cables, capacitors, parallel studs, and needle gaps. Under dry conditions all corona-starting voltages are found to be well above the operating voltages of the system. *Electrical Engineering*, April, 1944, pages 189–194 (Transactions), 3 illus.

How to Maintain Fractional Horsepower Motors. John H. Allen. An article giving instructions for the maintenance of 24-volt direct-current motors, which are standard to aircraft applications today. Detailed instructions for routine inspection and service operations are included; these are illustrated by photographs and sketches. *Aviation Maintenance*, May, 1944, pages 41–46, 140, 142, 144, 146, 10 illus.

Effect of Altitude on Electrical Insulation. Leo J. Berberich, Arthur M. Stiles, Graham L. Moses, and Cyril G. Veinott. This paper reports an investigation made to determine the requirements for insulation clearances for aircraft electrical apparatus rated up to 600 volts and intended for use at altitudes up to 65,000 ft. The tests were conducted on the ground under simulated high-altitude conditions and were made with a variety of materials, including the actual rocker ring of a high-production 28.5-volt d.c. generator. The materials used and the recommended striking and creepage distances resulting from the tests are tabulated. The recommendations are compared with certain existing standards. After a discussion of the laws of gaseous breakdown and of the conditions specified for the tests, it is explained that the work is divided into two parts.

The first part is concerned with determining the sparking or striking voltage through air gaps of varying lengths under varying atmospheric conditions. The second part is concerned with flashover voltages across varying lengths of surfaces of a number of insulating materials—also under varying atmospheric conditions. The materials and apparatus used and the methods followed in the tests are described. Tests were made with direct current and, in many cases, with 60-cycle alternating current to compare the effects of the two types of voltages. It is concluded that the results obtained are particularly useful in determining what breakdown voltages may be expected at various altitudes when only sea-level test data are available and what voltage may be impressed at sea level to duplicate the effect of any given voltage at a higher altitude. *Aero Digest*, April 1, 1944, pages 84–86, 207, 209, 210, 12 illus.

Electric-Circuit Burning-Clear and Damage Phenomena on Aircraft Structures. C. M. Foust and J. G. Hutton. The extensive use of 28.5-volt d.c. aircraft systems, the proposed 120-volt d.c. system, and the consideration being given a three-phase 120-208-volt a.c. grounded-neutral system for high-altitude planes necessitated an investigation into the burning-clear and damage phenomena on all circuits. Short circuits were applied on an aluminum-alloy section of an airplane, and oscillograms of short-circuit current and voltage were taken. In both the a.c. and d.c. systems it was found that the fault-damage and burning-clear phenomena depended upon the energy level in the short-circuit area. When the contact area between the conductor and aircraft structure was small, the energy level was high, and the fault burned itself clear. In such cases the aircraft structure was perforated. Increase in contact area and a consequent reduction in energy concentration resulted in a sustained fault current. In some of these cases a definite welding of the conductor to the aircraft structure occurred, while in others no burning took place. *Electrical Engineering*, April, 1944, pages 198–204 (Transactions), 9 illus.

Engines

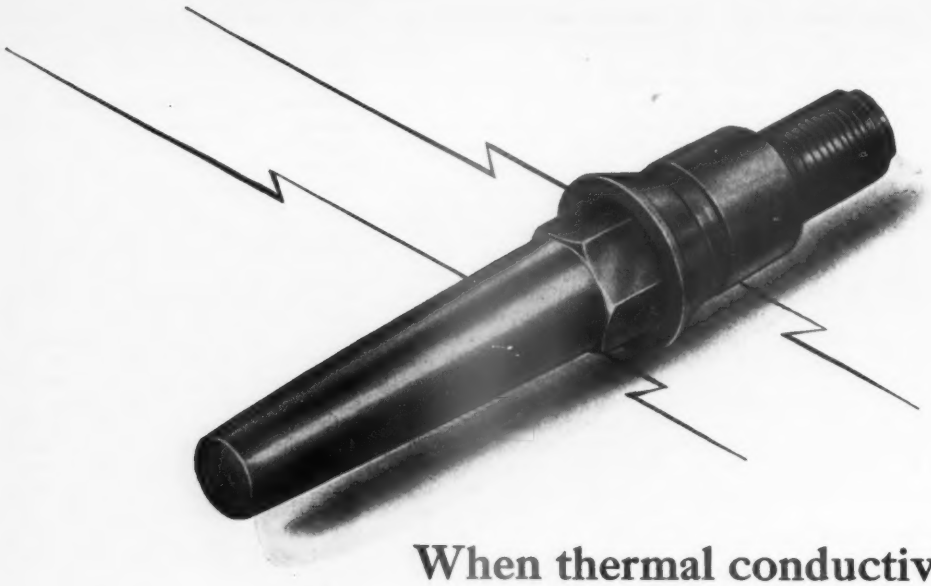
Aircraft Engines. Capt. Burr Leyson. A compendium of American aircraft engines, with descriptive data accompanying illustrations of each. The group of photographs is preceded by a brief review of aircraft-engine development trends. *Skyways*, May, 1944, pages 32–45, 38 illus.

Portable Pressure Tank Aids Pre-Oiling. An article on the construction, operation, and advantages of a portable tank for raising the temperature of oil for an aircraft engine before it is introduced into the cold bearings. With this tank, pressurization and heating may be accomplished in the hangar and the oil may then be applied to the engine at any point on the field. The unit has no motor, pump, nor moving parts and eliminates the necessity for retaining electrical or pneumatic connections while it is in use. It is reported to be light enough for one man to haul around. A drawing of the portable pressure tank is shown. *Aviation*, April, 1944, page 169, 1 illus.

Some Physical and Wear Characteristics of Porous-Chromium-Plated Rings. Tracy C. Jarrett. The use of porous-chromium-plated rings in aircraft engines as a means of increasing the number of hours between overhauls is discussed. The effect of temperature on the hardness of chromium plate is studied, and field tests of engines provided with porous-chromium-plated rings in two types of barrels are described. *SAE Journal*, May, 1944, pages 222–224 (Transactions), 5 illus.

Machining Cylinder Fins. A description of a special Maxicut lathe for machining the cylinder cooling fins of aircraft engines. Application of the machine is exemplified by its use in the production of the Bristol Hercules engine. The finning lathe is reported to be of massive construction and all-automatic operation. It can be employed for cutting either concentric or eccentric fins and may use more than 100 tools simultaneously. Details are given on its construction and operation, with attention called particularly to the tool slides, the tool equipment, and the special provisions for insuring an abundant supply of coolant. *Aircraft Production*, April, 1944, pages 155, 156, 5 illus.

Aircraft-Engine Inlet and Exhaust Porting. Vincent C. Young. Consideration is given to problems connected with the selection of valve-port dimensions that will fulfill performance requirements and result in reasonably good durability of the parts directly affected by the porting. The paper deals with modification of the cylinder head to revise port dimensions; no attempt is made to consider other factors—valve diameter, lift, etc.—in-



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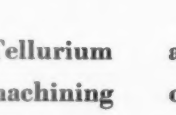

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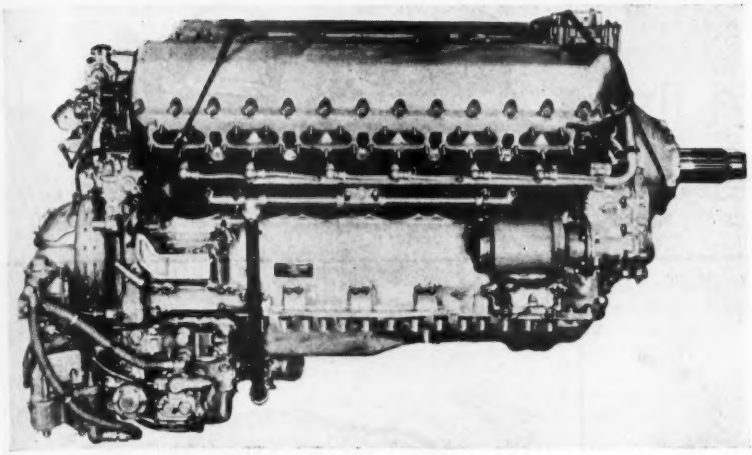


The Rolls-Royce 1,500-hp. Griffon engine.

fluencing the breathing and exhausting of the engine.

It is stated that, as a general rule, it appears desirable to keep the ports as small as possible. This procedure permits flexibility in obtaining proper sections to withstand thermal and hydraulic loading, gives maximum flow of coolant (whether liquid or air), makes reasonable temperatures possible, and gives the best flow characteristics of the passages in the head, which control the flow of inlet and exhaust gases. A port constant is used to simplify design and as a handy means of expressing velocities. This represents the slope of the line obtained by plotting the port area against a factor of speed displacement.

Attention is given to the cooling of the exhaust valve as affected by heat transfer from the head section to (1) the relatively cool new charge, (2) the heat transferred to the coolant through the seat, (3) the heat transferred to the coolant by the stem, and (4) the heat transferred to the port gases during the other-than-exhaust portions of the cycle. It is stated that the maximum flow coefficients will be obtained for intake ports if the approach passages are of uniform section with no re-entrant curves and if the actual passage shape between the seat and the valve is considered as a venturi.

Cooling requirements for the inlet port are not so stringent as for the exhaust, so that guide and boss can be designed with emphasis on flow characteristics rather than on cooling effect. *SAE Journal*, May, 1944, pages 203–206 (Transactions), 3 illus.

The Napier Sabre Engine. Part I. J. A. Oates. The beginning of a detailed production analysis of the Napier Sabre engine. Part I describes the shop layout and work flow, traces the production sequence, and tells how the operations of machining the crankcase and cylinder block are carried out. Some of the topical headings into which the study is divided are sleeve valves, the crankcase, shop layout, machining sequence, joint faces, boring, and airscrew-shaft bore. Others pertain to front and rear registers, final boring, the cylinder block, angular drain holes, and cylinder bores. Specifications of the Napier Sabre engine, as well as a full-page schematic drawing indicating the important features of its design, supplement the analysis. *Aircraft Production*, April, 1944, pages 177–186, 30 illus.

United States Aircraft Engine Specifications. Specifications for American aircraft engines are given in tabular form. The table shows the manufacturer, engine designation, number of cylinders, horsepower at stated r.p.m., total displacement in cubic inches, dry weight, bore in inches, stroke in inches, fuel consumption in lbs. per hp. hour, diameter, length, and planes in which the engine is used. *Skyways*, May, 1944, pages 66, 67, 1 illus.

Das Massenrueckdrehmoment von Mehrzylindermotoren (Mass Antitorque Moment of Multicylinder Engines). A. Kimmel and M. Laepple. This report is based on previous investigations made on single-cylinder engines (reviewed in the AERONAUTICAL ENGINEERING REVIEW, May, 1944). It deals with the determination of the mass antitorque moment on conventional in-line, V-, and radial engines. The procedure is presented in a form suitable for practical application. *Luftfahrtforschung*, January 6, 1944, pages 301–310, 8 illus.

Flight Operations

Long-Range Cruising Analysis and Control. Frank B. Lary. An analysis of a hypothetical airplane is made to determine values of indicated air speed and engine speed and manifold pressure yielding the maximum number of miles per gal. Amplification is attempted on the major variables influencing airplane, propeller, and, especially, engine economy. Charts are given and a form for presentation of cruise-control information to the pilot or flight operator is offered. The article includes instructions for use and suggestions for obtaining the desired degree of simplicity and further refinement. *SAE Journal*, May, 1944, pages 191–197, 221 (Transactions), 10 illus.

Payload versus Operating Speeds in Air Transport Operations. J. G. Borger. This paper considers the effect of some design factors on the operating speed of aircraft and the effect of operational factors that set up and control the speeds at which an airplane should be flown once it has been delivered for service on a given route. The importance of operational control of speeds through the use of constant power in air-transport flights is emphasized. *SAE Journal*, pages 207–212 (Transactions), 6 illus.

Flight Technique

Side Slide. William C. Littlejohn. The thesis of this article is that an airplane has to fly with its thrust axis at an angle to the direction desired to be flown. Rationalizing his belief that an airplane continually flies with its nose yawed to the right of its flight path in power-on flight as a result of torque, the writer discusses the factors that cause and affect this "side slide." Rather than being controllable by the pilot, the extent of the side slide is demonstrated as being dependent upon the indicated air speed, power load, aerodynamic characteristics, and fuselage design of the airplane. *Air Facts*, May, 1944, pages 28–32, 3 illus.

Flight Testing

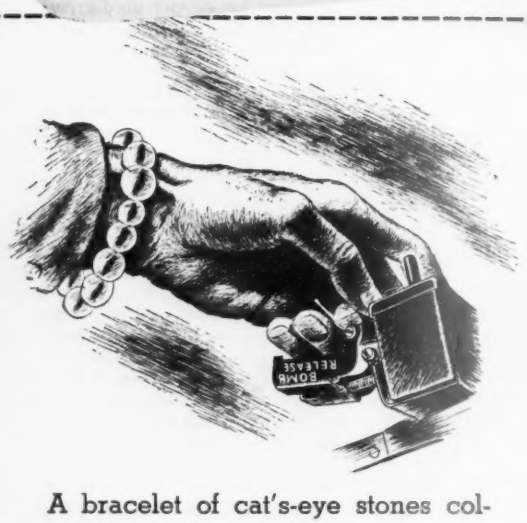
Flight Research. Thomas A. Dickinson. The evolution of test flying is discussed. A description is given of the manner in which Consolidated Vultee established a flight-research department at San Diego. The activities of this department are outlined and the testing equipment used is illustrated and described. *Aircraft Age*, June, 1944, pages 22, 23, 56, 57, 4 illus.

Gliding and Soaring

Post-War Gliders. Hawley Bowlus, as told to Howard Kegley. The commercial use of the glider in the postwar period is discussed. It is noted that the United States will have a large number of trained pilots and maintenance men after the war. A natural development of such a technical background is an all-encompassing glider transportation system, which, it is stated, is now in process of development. The possibilities of the tow-plane and glider pick-up systems are considered. *Aircraft Age*, June, 1944, pages 18, 19, 4 illus.

Why a Powered Glider? Stanley R. Corcoran. Various methods of launching gliders are discussed. After noting that, in all cases, outside aid is necessary before a flight is possible, the author emphasizes the fact that a better method must be developed for getting a glider into the air. The advantages gained from the installation

They wouldn't fly without them...



A bracelet of cat's-eye stones collected from a South Sea lagoon, hung around the "dropping" hand of a bombardier through twenty months of combat flying.

On every mission a sentimental farm boy, now a tail gunner, carried a small sack of the good earth from the farm back home.

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of an auxiliary power plant of sufficient power for take-off and a fair rate of climb are discussed. *Gliding*, April, 1944, pages 3, 10, 3 illus.

History

A History of British Aeronautical Periodicals. C. G. Grey. A detailed account of the development of the various British aviation publications. A chronological list of the aeronautical periodicals is shown. *Aeronautics*, April, 1944, pages 28–36.

Guesswork to Clockwork. G. E. Nistal. A half century of development of airplanes and engines is reviewed briefly. The article is accompanied by illustrations of early airplanes and a series of photographs depicting the evolution of airplanes and engines from early days to the present. *Air News*, May, 1944, pages 21–25, 29 illus.

Speed to Win. Maurice Roddy. Indicating some of the contributions of air racing to the development of aeronautical science, this article reviews performances, records, and outstanding participants of the Cleveland Air Races. It also proposes the holding of "Air Olympics" after the war. *Southern Flight*, April, 1944, pages 25–27, 44, 9 illus.

Aviation's Oscar. Devon Francis. A story of the Collier Trophy and the aeronautical achievements for which it has been awarded. While reviewing and commending the winners of the award, the article also mentions concurrent achievements of equal value which were necessarily passed by and points out the problems involved in trying to designate one aeronautical development as the "best" of the year. Some biographical data about the donor of the trophy, Robert J. Collier, are included. *Air News*, May, 1944, pages 32–36, 19 illus.

Hydraulics

Calculating Liquid Pressure Drop in Hydraulic Tubing. Jack Jerome. A calculator devised by Consolidated Vultee Aircraft Corporation for determining the pressure drop in hydraulic tubing is described. An adaptation of slide-rule technique, it is stated to make possible the reduction of the problem to a matter of a half-minute in time and the setting of two simple scales. The device is essentially a plot of pressure drop against rate of flow on a logarithmic grid, with the curve scribed on a transparent sheet and superimposed on the grid. It can be adapted for use with a single fluid or so constructed that pressure-drop problems involving any liquid may be solved. The mathematical principles are explained and a typical example of the calculation is carried through. The advantages of the device are summarized as follows: (1) No auxiliary straight edges are required and no pencil marks are made on the chart. (2) Rapid determination is made of pressure drop, rate of flow, tube size, temperature, viscosity, or specific gravity for any set of conditions. (3) Only three scale settings (two with the simplified calculator) are required to obtain a pressure-drop vs. flow curve for any set of conditions. (4) The flow condition—laminar or turbulent—is readily apparent. (5) The calculator may be built pocket-size, with a high degree of accuracy over a narrow range or a fair degree of accuracy over a wide range. *Aero Digest*, April 1, 1944, pages 100, 102, 104, 128, 6 illus.

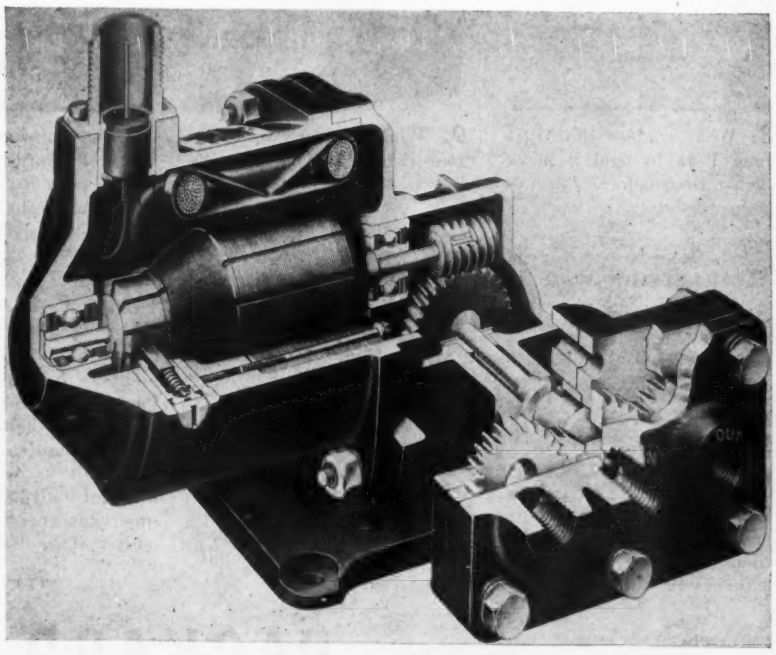
Production-Line Remedies for Hydraulic Headaches. Comdr. Harry J. Marx. The results of a survey of seven hydraulic subcontracting plants are reported. This survey was conducted for the purpose of determining whether any of the contractors' production practices were contributing to difficulties in servicing the hydraulic units. Using the designations of Plant "A," "B," etc., a detailed analysis is given of the procedures encountered at each plant. The general conclusions are: (1) Virtually all manufacturers were sincere in their intention to turn out an all-round satisfactory product. (2) Lack of knowledge covering hydraulic-system requirements was much in evidence. (3) Dirt was found to be the greatest source of trouble; its elimination was absolutely necessary in order to improve conditions. (4) Material handling, assembly, testing, and inspection were four important operations that required both improvements and closer control. (5) Test equipment did not always incorporate adequate filtration and, in some instances, did not satisfactorily assure proper functioning of the various tests. A summary of recommendations for the reduction of hydraulic-equipment problems is included in the report. *Aviation*, April 1944, pages 148, 149, 265, 267, 269, 271, 273, 275, 6 illus.

Hydraulic Jacks. The function and importance of the jack in hydraulic systems are explained briefly. Among the types of jacks noted and illustrated are a general utility jack, one with glanded-pivot spindle, one incorporating bleeder valves, another with glanded piston-rod spindle, and two of the Aerol wheel types. *Canadian Aviation*, April, 1944, pages 154, 156, 5 illus.

Inspection

Fluoroscopic Inspection of Light Metal Castings. Robert Taylor. This article describes the use of fluoroscopy for the inspection of aluminum and magnesium aircraft parts. Consideration is given to present industrial applications of the method of visual examination, that is, examinations without a photographic record. The limitations of fluoroscopic inspection are also discussed. Information is given about available equipment. A combination conveyer-fed machine designed for both fluoroscopic and radiographic inspection is described. *Metals and Alloys*, April, 1944, pages 869–873, 5 illus.; "Fluoroscopy and Radiography Combined in New Unit," *The Iron Age*, April 20, 1944, pages 76–78, 3 illus.; "X-Ray for Aircraft Inspection," *Industrial Aviation*, April, 1944, pages 34, 37, 44, 3 illus.

Periodic Inspection of "Mainliners." The periodic inspection system used by United Air Lines to check its transport planes is described. Tabulated information is furnished regarding the check given at every refuel-

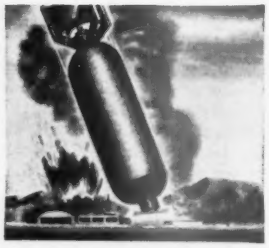


The Type 744-4 fluid metering pump manufactured by the Eclipse-Pioneer Division, Bendix Aviation Corporation, is designed to provide a metered flow from two outlets at capacities ranging from 1/2 to 3 gal. per outlet. Its weight is 4 lbs.

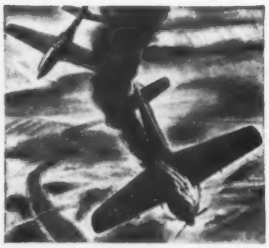
QUIZ for plane-minded readers

If you can answer nine of these questions correctly, you're good!

A score of eight correct answers is fair, and seven is average.



1. What fighter plane earned the name "B-40" by dropping 1,000 lb. bombs on Jap targets in Burma?



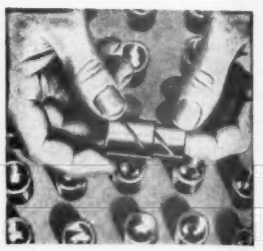
2. What plane has been called "the world's fastest fighter?"

3. What is conceded to be the "fastest bomber in the world?"

4. What is the name of Britain's heaviest bomber?

5. What fighter plane became known as the "tank buster" in the North African campaign?

6. Who powers the Mustang, Warhawk, Hurricane, Mosquito, and Lancaster — and the famous PT boats?



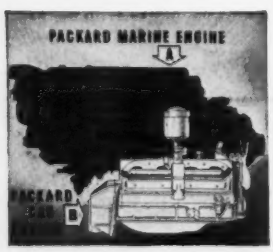
7. What is the finest surface measurement used in making Packard - built Rolls - Royce aircraft engines?

8. What enables the Mustang P-51 to fight 2 miles higher than before?

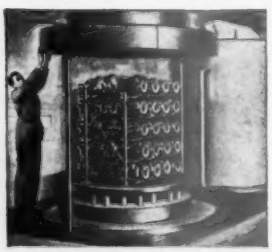
9. What does a two-stage two-speed supercharger do?

10. The top speed of blades in a Packard-built supercharger equals: an express train? A rifle bullet? Sound?

11. What famous fighting boats depend for their speed on aircraft-type engines?



12. "A" weighs 4 times as much as "B". Is "A" only 4 times as powerful as "B"? 6 times? 12 times?



13. Can new methods used in making war engines (like nitriding, above) help to build better postwar cars?

ANSWERS:

1—P-40 Warhawk. **2**—Mustang P-51. **3**—Mosquito bomber. **4**—Lancaster 4-motor bomber. **5**—Hurricane. **6**—Packard (Rolls - Royce engines for the planes; Packard marine engines for PT's). **7**—Millionths of an inch. **8**—A Packard-built 2-stage 2-speed supercharger. **9**—Packard-built 2-stage 2-speed superchargers compress thin air, permit high-power performance even in the stratosphere. **10**—A rifle bullet and sound. **11**—Navy PT boats (powered by Packard marine engines of aircraft-type design). **12**—12 times. **13**—Yes, many of them. Your future Packard will be better built, longer lasting, more economical as a result.

ASK THE MAN WHO OWNS ONE

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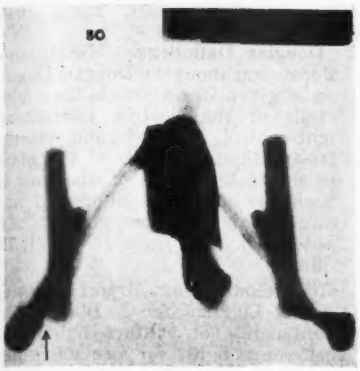

Fluoroscopic inspection of castings permits the detection of defective parts that may fail in service. The illustration shows a magnesium-alloy aircraft casting that has a stress crack extending up from the foot at the lower left and into an adjoining web. Penetrameters illustrating the sensitivity of the process are shown in the radiograph just above the casting.

ing stop or at approximately every 1½ hours of flying, the check given prior to the completion of 50 hours of flying, and the check given prior to the completion of 125 hours of flying. *Aviation Maintenance*, May, 1944, pages 27–34, 25 illus.

Cabinets Facilitate X-Ray Inspection. Robert Taylor. A cabinet for the X-ray inspection of aircraft propellers is described. Built by the Kelly-Koett Manufacturing Company, the lead-lined cabinet has a motor-driven charging car, a motor-operated X-ray tube positioner, and air-operated doors. It is just large enough to hold the work. The tube is operated by remote control, obviating the need for the operator to walk into another room while the exposure is being made and providing a more compact space arrangement. It is suggested that, in addition to aircraft propellers, this cabinet may be utilized for the inspection of crankcases, bar stock, rolled tubing, valves, airplane engine parts, sheeting, and large groups of spot welds. *Aero Digest*, April 1, 1944, page 88, 1 illus.

To combat high-altitude flight temperatures as low as −60°F., a newly designed wool felt shoe insert is being used. Developed by the Pioneer Products Division of the General Electric Company, the insert is wired in a snakelike design so that heat is disseminated evenly to all parts of the foot and ankle area.

Instruments

The Driftmeter. A general description is given of the design and operation of the drift meter, which is used to measure the angular distance that an airplane is forced from its compass course by the wind. *Air Tech*, April, 1944, page 40, 3 illus.

Precision Altimetry. Philip Kissam. It is noted that, with the development of the airplane, altimeters have undergone considerable improvement, both for use in the airplane itself and as an aid to the meteorologist in forecasting weather for airplane operation. With an improved instrument it should be possible to obtain more accurate elevations. If sufficient accuracy could be obtained, the possibility of materially reducing the cost of vertical control for all mapping operations would exist.

The writer presents the details of a pilot project at Princeton University. This was sponsored by the Wallace & Tiernan Products company in order to discover what could be done with an instrument designed especially for ground surveying. It is stated that the results indicate that both the two-base and single-base methods are entirely practical and satisfactory from a standpoint of operation and that the results obtained are well within the limits of accuracy desirable for high-grade mapping. *Photogrammetric Engineering*, January-February-March, 1944, pages 25–43, 2 illus.

The Story of TWA's Instrument Overhaul Department. William Maxfield. T.W.A.'s superintendent of maintenance relates how an air line takes care of more than 3,000 instrument units. Devices developed to make overhauling faster and more efficient are described. *Air Transport*, April, 1944, pages 34–39, 8 illus.

Production Line Altimeter Overhaul. An account of how production-line methods have been adopted at the Middletown Air Depot for overhauling altimeters. It is explained that, under the new system, each person works on a certain phase of the job, cooperating with fellow workers until the finished product is obtained. The assembly and inspection operations for each phase are shown in tabular form. *Aviation Maintenance*, May, 1944, pages 35–37, 4 illus.

Maintenance

Maintenance Magic for Piston Rings. G. E. Nistal. A review of maintenance procedures for aircraft-engine piston rings. The article contains data and recommended practices obtained from many sources, including the overhaul manuals of various engine manufacturers, air-line and military repair shops, and manufacturers of piston rings. The procedures recommended are for the ring maintenance of high-output aircraft engines. Various maintenance operations are illustrated. *Air Tech*, May, 1944, pages 28–31, 12 illus.

Inspection and Servicing of Hydromatic Propellers. Some of the steps in hydromatic-propeller inspection and servicing are listed. The operations described include preflight, 25-hour, 50-hour, and special inspections; minor blade repair; minor repair procedure; straightening and condemnation of blades; the cleaning of propellers; and blade marking. The information is given in tabular form, stating the parts to be inspected or repaired and the action to be taken or the work to be performed. *Aviation Maintenance*, April, 1944, pages 51–56, 14 illus.

Fuel Tank Service on the Small Plane. A collection of service hints for the proper maintenance of light-aircraft fuel systems. *Aviation Service Magazine*, March-April, 1944, pages 10–13, 36, 9 illus.

Alighting Gear Maintenance. An outline of the procedures and tools used by American Airlines to change and overhaul large landing-wheel assemblies. The information is given in the form of a series of 17 pictures with descriptive captions. *Aviation Maintenance*, April, 1944, pages 60–62, 17 illus.

It Came Home by Highway. How a damaged DC-3 was towed on its own landing gear a distance of 320 miles to a repair base. The trip, completed in short time, made possible the plane's quick return to priority service. *Air Transport*, April, 1944, pages 73, 75, 4 illus.

Royal Air Force Ground Equipment. Part II. Wing Comdr. S. E. Hernden. A continuation of a description of versatile ground equipment employed by the Royal Air Force for the efficient handling of airplanes. The equipment discussed includes a quick-removal jacking trolley for heavy aircraft, lifting bags for raising damaged planes to a position that permits work to be done on the undercarriage and engine, a salvage trolley for fighter aircraft, a wing-handling trolley, and an ambulance crane. Other equipment described includes R.A.F. standard hydraulic jacks, a standard oleo pump, an aircraft weighmeter, a starter trolley, and a trolley for transporting high-pressure oxygen cylinders. *Aviation Maintenance*, April, 1944, pages 47–50, 19 illus.

What D'Ya Mean It Can't Be Done! A description of emergency repair jobs performed by the Fifth Air Force of the Air Service Command to keep combat planes flying in New Guinea.

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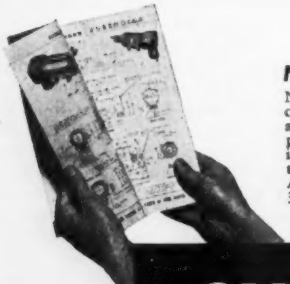

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Aviation Maintenance, April, 1944, pages 67–69, 6 illus.

Douglas Dauntless. Maintenance information about the Douglas Dauntless is given in an article describing details of the electric, instrument, flight-control, and hydraulic systems. Constructional features of the plane are shown by means of diagrams in which the parts are numbered and named in an accompanying list. *Air Tech*, April, 1944, pages 17–23, 71, 72, 8 illus.

Maintenance of Airport Runway Contact Lights. R. C. Blatt. The maintenance of contact lights and flush range lights for airports is discussed. Sections deal with the installing of new ANC leads on existing bases, the minimization of moisture leakage, orientation of the optical system, sealing of cable entrances and top-assembly joints, and cleaning and relamping. *Aviation Maintenance*, April, 1944, pages 63, 64, 178, 180, 182, 184, 5 illus.

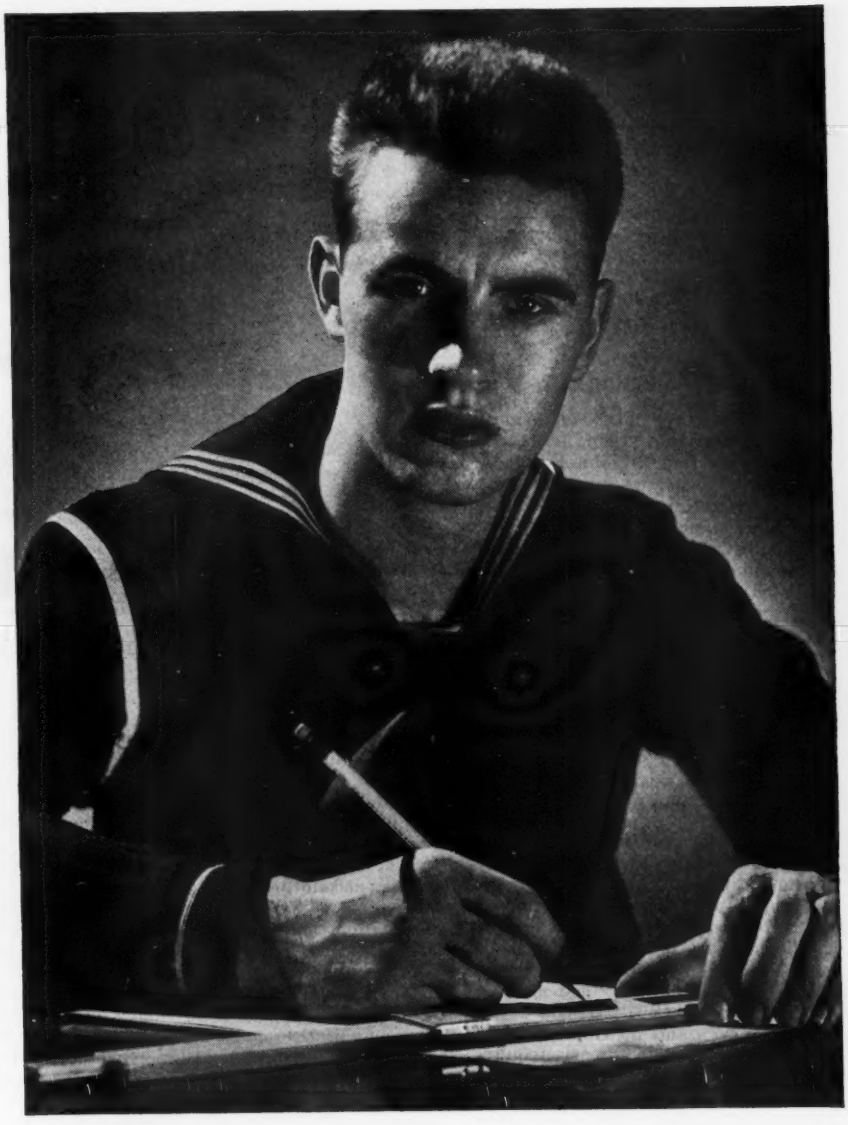
Management

"No One of Us Knows as Much as All of Us." E. J. Tangerman. The employee's suggestion system used by the Eastern Aircraft Division, General Motors Corporation, is described. It is explained that the plan is administered by a committee of five appointed by the plant manager from the engineering, personnel, time-study, and accounting departments. None of these committee members are executives, but all are qualified by experience to judge the value of suggestions. A suggestion, to be eligible for award, must be an idea for increasing production, improving quality, saving time or material, reducing waste, eliminating the need for a tool or fixture, eliminating an accident hazard, improving working conditions, or aiding in the protection of property.

The plan involves the usual suggestion boxes, placed conveniently throughout the plant, and serially numbered blanks, made available through foremen, superintendents, and personnel offices. *Wings*, May, 1944, pages 1005–1008, 11 illus.

Decentralization of Willow Run. E. L. Warner, Jr. This article tells how Ford solved the labor-shortage problem experienced when the organization took on the production of B-24 Liberators at Willow Run. Details of the decentralization program are described. Manufacturing and subassembly operations were diverted to other Ford plants and outside companies in cases where labor and production facilities were available. It is stated that decentralization eliminated the need for more than 22,000 employees at Willow Run, and made available more than 800,000 sq. ft. of floor space at the plant. *Automotive and Aviation Industries*, April 15, 1944, pages 18–20, 85, 86, 88, 5 illus.

So That's Where You Work! It is stated that because family under-



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Behind our production effort are the men of science... engineers, designers, researchers, mass-production experts.

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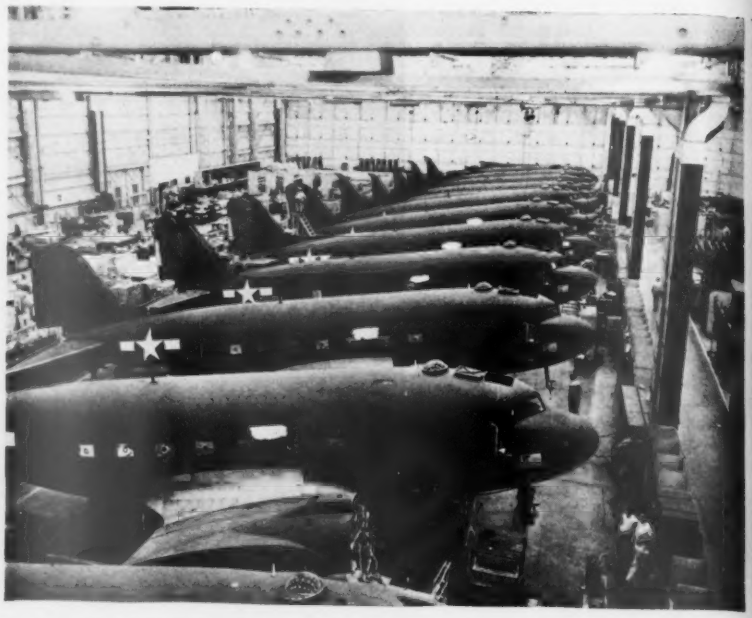
standing of each aircraft worker's importance on the job is necessary in maintaining the employee's morale, more and more plants are planning "Family Days." Details are given of three such affairs—those held at Grumman on December 7, 1941, at the Curtiss Wright Columbus plant on July 4, 1943, and at Republic Aviation Corporation on October 3, 1943. How these affairs reduced absenteeism and improved worker morale is described. *Wings*, May, 1944, page 1009, 1 illus.

Marketing

A Three-Way "Fix" on Aircraft Markets. E. H. Cargen, Jr., and L. J. Stosik, as told to John Foster, Jr. Results are reported of a survey to determine the postwar markets for American-manufactured aircraft. The method by which the study established minimum, middle, and maximum estimates is explained. Statistical projections are given for military aircraft and for commercial aircraft in three classifications: for domestic trunk lines, for feeder lines, and for American-operated international lines. Some prognostications with regard to aircraft for export purposes are included. Tables and charts accompany the report. *Aviation*, April, 1944, pages 116–118, 295, 297, 299, 301, 6 illus.

Translating Post-War Marketing Plans Into a Current Sales Program. Arthur S. Brown. An outline of the Scott Aviation Corporation's program for applying efficient merchandising methods to the marketing of aircraft accessories. It is reported that the company's sales policy emerged from a study of the marketing problems of aircraft operators and distributors. This study revealed four primary requirements: (1) the provision of adequate profit margins for both dealer and distributor, with sales expense kept at a minimum; (2) some method of assuring the dealer and distributor of the maintenance of his profit position; (3) retention of the good features of exclusive territories without their many disadvantages; (4) an adequate educational program in modern merchandising methods for both dealers and distributors. As a result, the sales policy encompasses five major components: The first covers the contract and conditions under which distributors operate; the second, the contract and conditions under which the dealers operate; and the third, the stock check forms required from all contract resale agencies to assure the maintenance of adequate stocks of saleable merchandise. The fourth point is concerned with the protection of the profit positions of both dealers and distributors; and the fifth provides for a long-range program by which the aircraft-accessories manufacturing company will supply sales information and educational aids to its resale agencies. *Aero Digest*, April 1, 1944, pages 58, 126, 128.



Douglas C-47 Skytrain transport planes on the assembly line at the Long Beach plant.

Materials

Corrosion Prevention in Aircraft. S. H. Phillips. Procedures are recommended for the protection of aircraft metals against corrosion. The article begins with a brief description of the chemistry of corrosion, an explanation of the end points of corrosive actions, and an account of the types of corrosive attack on different metals. Specific precautions are advised to prevent the introduction of corrosion during the storage of parts or resulting from the following causes: general shop conditions, tools and equipment coming into contact with the metals, handling of the raw material, cleaning solutions, etc. In conclusion, it notes recent theoretical studies that have been made on the subject and mentions the difference of opinion about the use of the salt-spray test. *Industrial Aviation*, April, 1944, pages 5–7, 56, 5 illus.

Effect of Wartime Developments on Future Steels. W. P. Eddy, Jr. It is emphasized that the needs of war machines have made it necessary to accelerate many old projects and to inaugurate some new ones in the field of steel metallurgy. These developments are discussed and predictions made as to how future steel practices will be affected by these metallurgic accomplishments. Present accomplishments and future trends are discussed along the following lines: fatigue endurance; heat-treatment; castings; welding; alloy evaluation; hardenability as a primary requirement; special addition agents; and NE steels. *SAE Journal*, May, 1944, pages 169–180 (Transactions), 11 illus.

Stand der Wissenschaft vom Holz (The Status of the Science of Wood). F. Kollmann. This article describes how wood research, in conjunction with the natural and the technical sciences, has gradually built up an extensive science of wood. *Zeitschrift des Vereines Deutscher Ingenieure*, November 27, 1943, pages 737–752, 33 illus.

Aircraft Radiator Fabrication Improvement. William A. Chapin and Harry D. Moshenrose. Results are reported of a study to eliminate aircraft radiator leakage caused by zinc-chloride flux corrosion. A proposed solution, based on the use of resin as a soldering flux in the radiator fabrication processes, is described. The causes for and the findings of the study are set forth in a summary as follows: (1) The problem of corrosion in aircraft cooling systems is a pertinent and important part of the development of first-rate fighting airplanes. Although the subject has several ramifications, the major factor is the chemical action of foreign substances, such as the soldering flux used in the fabrication of the radiators. (2) The corrosive action of zinc-chloride flux on radiators, particularly of the honeycomb type, is a phase of the problem that has been thoroughly investigated; its correction would eliminate the major portion of the trouble that has been experienced with such radiators. The work that has been done with the honeycomb type of radiator has definitely established the fact that it is the corrosive action of the flux, and not mechanical or other factors, that has caused the major portion of the trouble with these radiators. (3) The methods of manufacture used in fabricating these radiators have not been of the best, in the light of the knowledge already available and that gained in this investigation. (4) A positive method of correcting the situation has been advanced and been shown to be practical from the standpoint of producing satisfactory radiators and from the standpoint of ease of production method. (5) Al-

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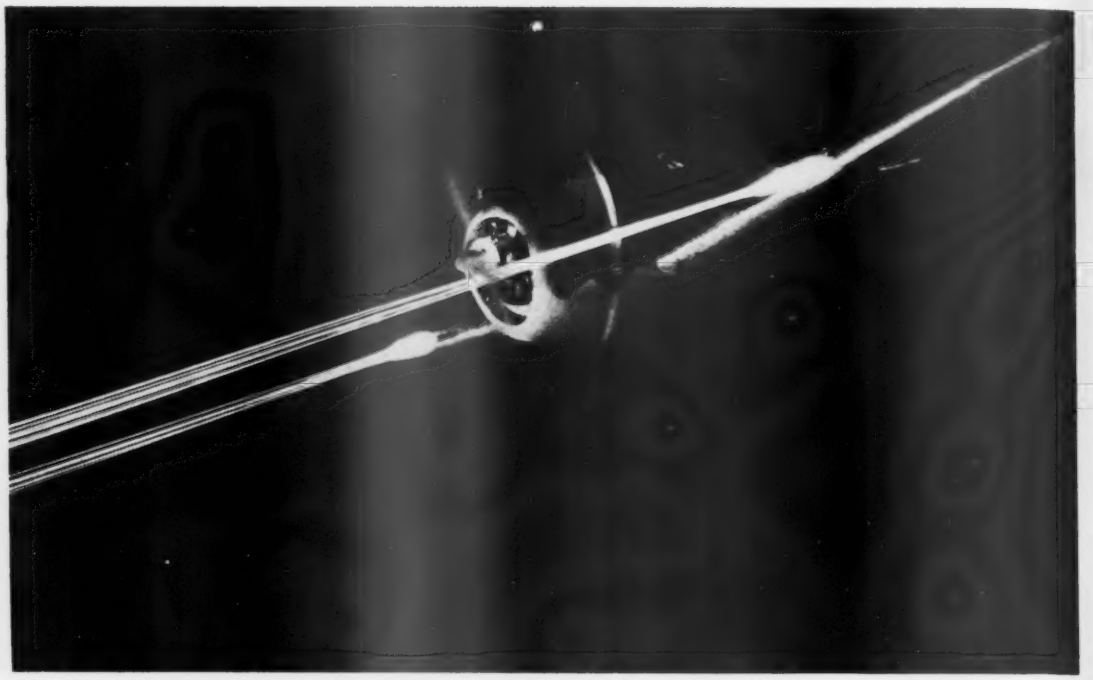

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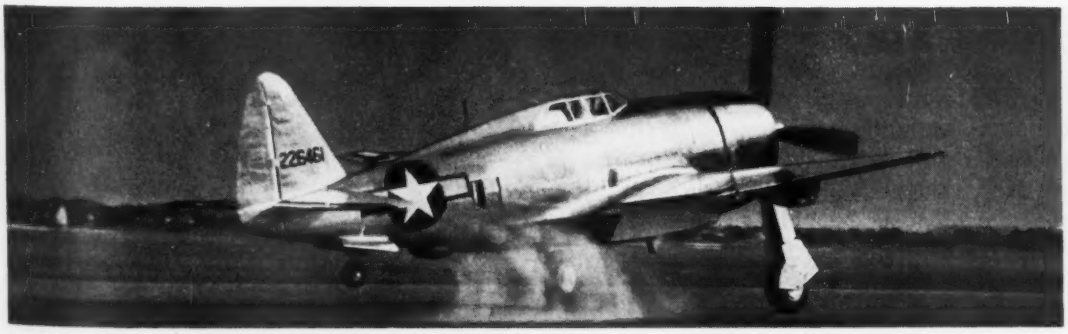

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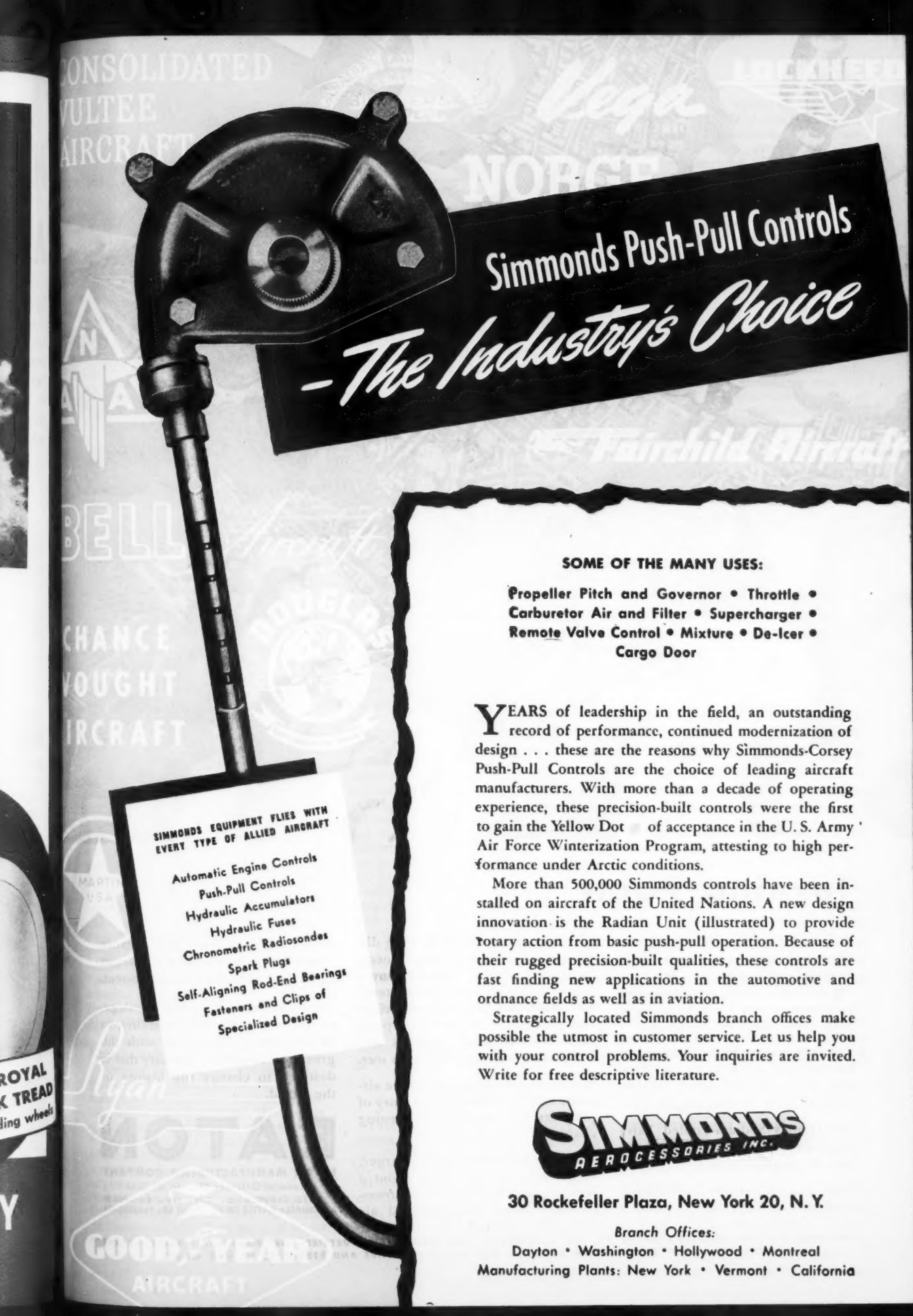

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though the radiators manufactured under the old methods, using corrosive fluxes, could possibly be improved to the extent that much better radiators could be produced, the introduction of the new method advanced would positively eliminate all danger of trouble caused by the retention in the radiators of corrosive flux. *Industrial Aviation*, April, 1944, pages 20–22, 24, 43, 7 illus.

Medicine

Psychologic Armoring for the Air Forces. Major William G. Barret. Pointing out that practically nothing in the way of scientific psychologic armoring of fighting men has been done in the United States, the writer presents a study of the subject. The organization and application of knowledge about psychologic warfare is discussed. It is stated that there is probably no branch of the military service where foreknowledge of psychologic factors can be better utilized than in the Air Forces. Sections of the article discuss the psychology of combat flying and special morale factors introduced by indoctrination of the type suggested. *War Medicine*, March, 1944, pages 142–145.

Some Factors Affecting the Incidence of "Bends" at Altitude. J. F. Fulton. A study of some of the precipitating causes, manifestations, and effects of decompression-sickness. The effects of exercise at high altitudes and exposure to cold upon the "bends" susceptibility of a given individual are investigated. Observations upon the postflight reactions of the "bends" patient are also reported, leading to the conclusion that "bends" are associated with local vascular occlusion and that the anoxic tissue subsequently pours toxic products stemming from tissue anoxia into the general circulation. In summary, the article states that decompression-sickness is divided into two phases: (1) the acute stage, developing abruptly at altitude, precipitated by exercise and cold and associated with premonitory vasoconstriction, pain usually localized in an area about a joint, sometimes "chokes," and often fainting and circulatory collapse; (2) a delayed stage developing after return to sea-level pressure, associated with lassitude, headache, and, when a more severe "postflight reaction" occurs, with neurological signs and circulatory collapse (primary shock). *The Military Surgeon*, April, 1944, pages 199, 200.

Biomechanics: A New Approach to Airplane Safety. Charles Murray Gratz. Successful cooperation between surgeons and engineers leads to an exchange of techniques known as biomechanics (a division of the larger sphere of biological engineering), a term used in describing the original mechanical heart. It is stated that the safety engineering of the airplane is now being coordinated with rescue and early surgical treatment of the survivors of aircraft accidents. Authenticated records of survival under seemingly impossible circumstances have

been presented. When such facts are combined with the biomechanical study of the human mechanism of survival and applications of it are made with intelligence, avenues are cleared for further accomplishments.

Injuries sustained in aircraft accidents by vulnerable and vital tissues of the human body are the result of physical forces that fortunately lend themselves to analysis. Once such forces are analyzed, studies can be applied to control and minimize their often fatal results. *Mechanical Engineering*, May, 1944, pages 313, 314.

Parachute Injuries. Capt. William J. Tobin. Results are reported of a survey on the injuries sustained by paratroopers during their training period. Conducted at the Parachute School, Fort Benning, Ga., the survey is particularly concerned with fractures. The following conclusions are offered: (1) Because of improved methods of training (mainly during the preliminary stages) and the recent change in the position of the feet in contacting the ground, the total injury rate is now lower although the number of jumps has increased. (2) Unequal distribution of weight in landing is a big factor in the production of injuries. (3) Most of the injuries of all types, but particularly fractures, are in the region of the ankle. (4) The majority of these are caused by a torsional or twisting element in landing, rather than heavy landings. (5) External malleolar fractures constitute the greatest number of fracture cases. (6) Fractures of os calcis are few in number. (7) Fractures of the posterior articular margin of the distal end of the tibia or "posterior tibial lip" represent an interesting picture. (8) Regardless of safety measures instituted, wind currents, with the resulting oscillations of the parachute, are the main factors in the production of injuries. (9) The injury rate, as a whole, is almost incredibly low considering the apparent hazards of parachute jumping. *The Military Surgeon*, April, 1944, pages 222–224.

Metallurgy

Principles of Heat Treating of Steels. T. F. O'Brien. Part I of a continued article discussing some of the fundamental chemical and physical aspects of the science of heat-treating. While the article deals with the heat-treatment of steel in general, some attention is given to aircraft steels.

In Part I the writer defines heat-treatment and furnishes a breakdown analysis of the definition. The characteristics of iron, steel, and alloy steels are described. The specific effects of alloys in steel are shown in a table. *Steel Processing*, April, 1944, pages 225–227, 250.

Über einige Eigenschaften elektrolytisch hergestellter Blei-Kupfer-Legierungen (On Some Properties of Lead-Copper Alloys Which Have Been Produced by Means of the Electrolytic Method). Franz Bollenrath. This report gives data on the electrolytic method of producing lead-copper alloys. It includes a study of hardness and how it is affected by annealing at various temperatures. Other subjects treated are structures and the variation of the structure caused by annealing and recrystallization. *Luftfahrtforschung*, December 8, 1943, pages 284–288, 15 illus.

Änderung der Festigkeitseigenschaften einiger Aluminiumlegierungen durch langzeitiges Erwärmen (Variation of the Strength Characteristics of Some Aluminum Alloys Under the Effect of Prolonged Heating). F. Bollenrath and H. Groeber. This article reports experiments made to determine the limit of tensional yield, tensile strength, fractural expansion, and hardness of some cast aluminum alloys and malleable aluminum alloys after being heated to various temperatures during a period of from 40 to 340 hours. These alloys were primarily intended to be used for pistons and cylinder heads of internal-combustion engines. *Luftfahrtforschung*, December 8, 1943, pages 288–291.

Kerbeinfluss bei üblicher und erhöhter Temperatur auf hochwarmfeste, austentische Werkstoffe (Effect of Notching on High-Grade Heat-Resisting Austenitic Materials at Normal and at Increased Temperatures). H. Cornelius and W. Schmidt. A report is given on tearing tests on smooth and on notched test bars of three high-grade, heat-resisting austenitic materials at 20°C., 450°C., and 600°C. The results of stress-strain tests at 450°C. and 600°C. are also given. These materials had received pretreatments that differed from each other in certain respects. *Luftfahrtforschung*, December 8, 1943, pages 292–296, 14 illus.

Aging and the Yield Point in Deep Drawing Steel Sheets. Part III. J. R. Low, Jr., and M. Gensamer. The third part of an article on the treatment of deep-drawing steel in wet hydrogen describes experiments undertaken to determine the most effective manner of carrying out the treatment. Factors investigated include the influence of the moisture content of the gas mixture and the influence of temperature and specimen thickness. The wet-hydrogen treatment of different grades of steel is discussed. Other sections deal with the influence of the rate of flow of the gas mixture, the effect of heating in air following wet-hydrogen treatment, the mechanical properties of hydrogen-treated sheets after cold-

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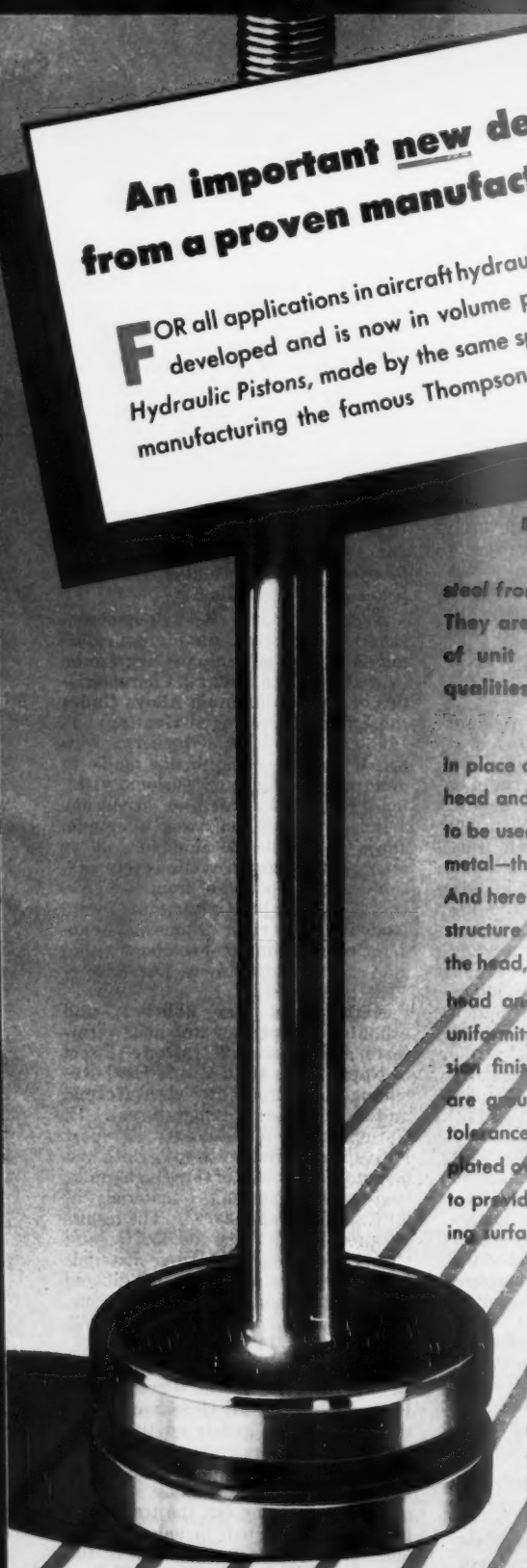

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rolling and annealing in air, and treatment with wet hydrogen containing nitrogen. *Steel Processing*, April, 1944, pages 232–235, 243–245, 4 illus.

Eigenschaften hochwertiger Stahlbänder und ihrer Punktschweissverbindungen (Properties of High-Grade Steel Strips and of Their Spot-Welding Connections). Heinrich Cornelius and Werner Samtleben. A report on an investigation of the properties of soft-annealed, refined, and cold-rolled strips. These strips were of nonalloyed, low-alloyed, and austenitic steels, in thicknesses of 0.3 mm., 0.6 mm., and 1.0 mm. The investigation was made to determine the following properties: static strength coefficients in the longitudinal and transverse direction—before and after annealing, reaction to corrosion in fresh water and in a sodium-chloride solution, proper coating materials as surface protection, and reaction to stress corrosion. Static strength, tensile strength, and fatigue strength of spot-welding connections were also investigated. *Luftfahrtforschung*, January 6, 1944, pages 311–322, 57 illus.

Der Einfluss von Magnesium, Silizium, Mangan und Eisen auf die Eigenschaften der Legierung "Duralumin Cu 30" (Effect of Magnesium, Silicon, Manganese, and Iron on the Properties of the Alloy "Duralumin Cu 30"). K. L. Dreyer and M. Hansen. A report of the Dueren Metal Works. It was desired to find a composition for "Duralumin Cu 30" an alloy containing about 3 per cent copper, that would make this alloy most advantageous with respect to its all-round characteristics. For this purpose, a systematic investigation was made of the effect of various additions of magnesium, silicon, manganese, and iron on cold and warm hardening, as well as on the recrystallization structure of this alloy. *Luftfahrtforschung*, January 6, 1944, pages 323–331, 22 illus.

Meteorology

Weather Networks of the Future. I. R. Goldsmith. A consideration of some of the problems involved in setting up adequate facilities to disseminate world-wide weather information for international air-commerce operations after the war. Among the problems discussed are the need for many new observation stations, the integration of all stations into one closely-knit network, the free distribution of all weather data, additional trained personnel, and a universal code for transmitting weather data between different countries. Interpreting the meteorologic significance of radiosonde observations, the writer claims that a far greater percentage of radio stations should be equipped with radiosonde in the future. He explains the difficulty with the present radiosonde—data can be obtained on an air mass without knowing the precise location of the air mass being analyzed—and reviews several means by which this deficiency might be corrected.

This latest version of the North American P-51 Mustang is equipped with a "teardrop" cockpit enclosure that allows maximum vision. The new enclosure is an aid to night flying, since it can be rolled back to give a view of the surrounding sky, unhindered by light from the instrument panel.

The article is concerned with the Army and Navy schools that are training men as meteorologists, the importance of oceanic forecasts, and the function of the "automatic weatherman." It demonstrates how the "automatic weatherman" can be used to reduce the number of men that will be required as observers and to lower the ultimate cost of operating the weather-information networks. *Aero Digest*, April 15, 1944, pages 111, 112, 206, 208, 4 illus.

Forecast the Weather Yourself. Charles R. Coates. A brief study of how the layman or novice can make accurate predictions of local weather conditions through an analysis of cloud forms, wind directions, and barometric changes. Phenomena identifying the different fronts or air masses, as well as the type of weather associated with each, are reviewed. In conclusion, principal weather indications are summarized as follows: A band of alto-cumulus clouds, increasing southwest surface winds, and a falling barometer indicate a definite cold-front approach. Increasing high clouds, thickening and lowering, with southeast to south surface winds, are indicative of a warm front. Thickening high clouds, increasing low clouds, a southeast to southwest surface wind, and a falling barometer precedes a low-pressure field of bad weather. Radio static is often caused by thunderstorms in the vicinity; sometimes they can be located by radio compass. Crackling static in all directions frequently indicates moderate storm with a large rain area. Static at one station and not at the second may indicate a frontal zone between the radio receiver and the station giving static. *Air Pilot and Technician*, April, 1944, pages 6–8, 42, 9 illus.

Military Aviation

Eyes of the Artillery. A discussion of the part light planes are playing as observation craft for the artillery in the specialized task of spotting for guns. How the first British Expeditionary Force took a number of these planes to France and the results obtained with them are related. The plane used was the Taylorcraft, later to be known as the Auster I. Preliminary tests conducted to determine how the 90-hp. Blackburn Cirrus Minor engine would stand up in military service are outlined. The performance of the plane in the North African theater of war is also described. *Aviation Review*, April, 1944, pages 13, 15, 2 illus.

How Our Bombers are Protected. Comdr. A. F. Bonnalie. An article discussing the characteristics and requirements of military aircraft, aircraft formations used in attacking enemy targets, and the protection of bombers by fighter aircraft. After comments about the types of aircraft in use in military operation at present, statistics are given concerning the percentage of losses in the Allied air forces compared with those of the enemy. The armament of fighters is discussed and various air-fighting tactics are explained with the aid of diagrams. *U. S. Air Services*, April, 1944, pages 12–14, 38, 4 illus.

"Maytag Messerschmitts." George Reiss. Stating that thousands of pilots now flying military aircraft ob-

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AIRCRAFT FINISHES

tained their initial training in "grasshoppers," the writer emphasizes the importance of light planes and describes the work they are performing at the war fronts. *Air Trails*, May, 1944, pages 19, 74–76, 3 illus.

Strategy of Air Bombardment Explained. Comments on Allied strategy in the air battles now being fought over Germany, in which the aim is stated to be the destruction of German fighter-plane strength and production. Figures are given to show the progress made in destroying German aircraft and facilities for building them; and results of the air war are traced chronologically. *U. S. Air Services*, April, 1944, pages 28, 30, 46, 1 illus.

Model Airplanes

Models of Airships Yield Best Results in Research for Full-Scale Structures. A brief report gives the experience of the Goodyear Aircraft Corporation with the use of models for testing purposes in aircraft structural research. It is stated that better results were often obtained by using models than by using full-scale structures. It was found that the smaller prototype permitted closer study and saved time, labor, and expense. *Contact*, April, 1944, page 30.

Naval Aviation

Seaplane Fighters. Thomas Marvin. Information is given about the seaplane version of the Japanese Zero fighter. It is reputed to have a top speed of 330 m.p.h., to have a ceiling substantially equal to that of the land-type Zero, and to maneuver and climb well. It is indicated that the seaplane type of fighter has not been favored by any nation other than the Japanese, but that it has proved successful as a seaplane carrier-based naval airplane. It is essentially the regular Zero fighter equipped with pontoons. The writer speculates on the possible uses for such a plane, including employment as a battleship or cruiser scout, as a convoy protector similar to the British Cata fighter, and as a defender of water-bounded territory pending the building or repair of shore airfields. Comments are made about the failure of the Allied forces to develop the seaplane type of fighter. Some of the seaplanes in current use are reviewed. Among these are the Vought Kingfisher, Curtiss Seagull, the German Arado Ar 95, the Caproni 310, and the Northrop N3-PB. Characteristics of the seaplane, both favorable and unfavorable to the craft as a fighter, are discussed. *Air Trails*, May, 1944, pages 35, 84, 85, 2 illus.

King Carrier. Lt. Comdr. B. J. Hurren. The case of the aircraft carrier is discussed. Figures are given on the probable number of carriers in the American and British fleets. The types of carriers being used are described. Problems concerning the handling of large formations of aircraft carriers, as well as lines of possible strategy in the Far Eastern theater of war, are considered. *Aeronautics*, April, 1944, pages 42, 43.

High Speed Airfields. C. A. Wulchyn. A description is given of the services performed by the Vought Kingfisher scouting planes with the Navy's battleships and cruisers. The work of these ship-based aircraft is related, with details included about the personnel, armament, and the ways in which the design and construction are particularly adapted for the work performed. *Air News*, May, 1944, pages 15–17, 12 illus.

Parachutes

Parachute Tips for Pilots. Lt. Malcolm Cagle. Some notes on the history and use of parachutes. After briefly reviewing highlights in the development of parachutes from da Vinci to World War II, the writer discusses types of parachutes, qualities required in materials used for parachutes, and the particular suitability of nylon for parachutes. He then refutes some common fallacies regarding the period of time that must elapse between the jump and the opening of the parachute, the oscillations of a descending parachute, and the sensations of parachuting. In conclusion, he offers several suggestions to parachutists on how to turn a "chute" so as to be facing the desired direction on landing, how to make a tree landing, how to make a water landing, how to evade Jap strafing on the way down, how to clear the airplane, and how to get out of the plane when it is in a violent spin. *Air Facts*, May, 1944, pages 64–70.

Personalities

Personality Behind British Merger. Some notes on the technical developments sponsored by F. G. Miles. The series of airplanes designed by Miles since 1932 are given and some of his views about postwar civil aviation are reported. *Commercial Aviation*, March, 1944, page 76, 1 illus.

Burdette S. Wright's Part in Two Wars. Esther H. Forbes. A biographic sketch of Burdette S. Wright, outlining his activities in the first World War and describing the part he is playing in the present conflict. *U. S. Air Services*, April, 1944, pages 17, 18, 44, 1 illus.

Photography

Photographic Aviation. Colonel Hall. An outline is given of the duties and equipment of the three types of units of the Army Air Forces which are performing aerial photography for the land, sea, and air forces. It is noted that these units produce maps, aeronautical charts, target charts, and mosaics. They also carry out photographic reconnaissance for strategic and tactical planning. An unusual achievement of a photo reconnaissance group operating in one of the war theaters is described. *Photogrammetric Engineering*, January-February-March, 1944, pages 44–48.

Plants

Race Track Production Line. Harold Keen. An account of how the Del Mar Turf Club was converted from a race track to a factory for aircraft-wing subassemblies. The story indicates the background of the men in charge of the enterprise, the problem of recruiting labor, the type of personnel employed, and the financial investment involved. *Flying*, May, 1944, pages 67, 138, 142, 144, 3 illus.

Plastics and Plywood

Moulded Plywood Fuel Tanks. As a demonstration of the application of progressive production technique to the manufacture of plywood units of compound curvature, the fabrication of external supplementary fuel tanks for the de Havilland Mosquito is described. Flexible-bag molding procedures are described. These procedures are characterized by the fact that the mold is not used for the preparatory work necessary in building up the layers of plywood.

Following a brief review of flexible-bag molding principles and strip pattern development, the article indicates the constructional details of the tank. It then traces the tank-fabricating processes through the operations of making the veneer subassemblies, molding, building the nose-reinforcing structure, assembling the internal structure, and sealing the interior. *Aircraft Production*, April, 1944, pages 189–195, 20 illus.

Plywood Characteristics Disclosed by Vibration Tests. A. J. Yorgiadis and J. M. Robertson. It is shown that the dynamic properties of plywood differ greatly from those of other aircraft materials and that the static tests for determining the properties of other aircraft materials are not sufficient for estimating the behavior of plywood when in vibration. The three most important dynamic properties not obtainable from static tests are listed as the fatigue strength, the dynamic modulus, and the damping capacity of the material. The three general causes of vibrations in aircraft structures are described as: vibrations of the power plant, aerodynamically excited vibrations—such as wing flutter, and vibrations caused by sudden changing loads—such as occur during landing and take-off. Various types of vibrations and the terms that express them are defined.

The dynamic testing equipment used is described, and a detailed account of the manner in which the tests were conducted, accompanied by diagrams and the mathematical calculations employed, is given. Information obtained about the damping capacity of ten different woods (including nine plywoods and solid birch), for stresses between 700 and 4,000 lbs. per sq. in. is given. Differences between the static modulus and the dynamic modulus are noted, and creep is ascribed as one of the causes of the discrepancy. It is stated that because of these differences computations of resonant frequencies must be based on the dynamic moduli.

Among the conclusions reached is the statement that damping capacity of plywood is greater than that of structural metals and less than that of plastics. A correlation was found between the damping capacity and dynamic moduli of plastics, plywoods, and wood. For the plywoods, the dynamic moduli increase with specific weight. The damping capacity of plywoods does not vary greatly within the range of ply thicknesses and molding pressures covered in the tests, and the damping does not vary greatly between the woods tested or with the doubling of the resin film. *Aero Digest*, April 1, 1944, pages 76, 77, 80, 81, 196, 198, 201, 202, 204, 6 illus.

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Plastic Plywoods in Aircraft Construction. R. D. Hiscocks. The general procedure followed in building wood aircraft is outlined, a typical fuselage fabricated from plastic plywood and veneer being used as an example. Basic design problems were solved by extensive investigations and tests conducted by the National Research Council. As an example of the wide range of possibilities of wood in war and postwar industry, a method of fabricating disposable fuel tanks for fighter planes from veneer and plywood is described. *Transactions of the A.S.M.E.*, April, 1944, pages 169–175, 15 illus.

Fatigue of Urea Assembly Adhesives. Albert G. H. Dietz and Henry Grinsfelder. This paper gives the results of research into the failures to be expected in glued joints of wooden aircraft in which cold-setting urea-formaldehyde synthetic resins are employed as adhesives. Particular attention is given to the nature of the failure, cycles of stress to failure at various amplitudes and stresses, and the probable fatigue limit of the assembly. The tests were carried out at room temperatures on an assembly adhesive representative of those employed in aircraft construction. Sections of the article describe the materials and test specimens, test methods, and test results. The conclusions formed are summarized. The paper was presented before a joint meeting of the Rubber and Plastics and Aviation Divisions of the American Society of Mechanical Engineers. *Modern Plastics*, April, 1944, pages 119–122, 160, 162, 11 illus.

The Elasticity of Plywood. H. Roberts. In the first two parts of this paper on plywood elasticity an elementary method is used to derive the variation in magnitude of the principal stiffness constants (viz., Young's Modulus, Modulus of Rigidity, and Poisson's Ratio) with angle to the grain for a single veneer and for a multilaminar panel. In the last part of the paper some of the formulas used for calculating critical stresses of plywood panels are given. *Aircraft Engineering* March, 1944, pages 68–72, 8 illus.

Air Processing Needs of Plywood Plane Parts. F. O. Jordan. A study made in connection with plans for a $2,000,000 plant to produce airplanes of bonded plywood reveals the importance of air conditioning in the production of wood aircraft parts. It is shown that, to achieve exact tolerances, precision control of air temperature and humidity is required. *Heating & Ventilating*, April, 1944, pages 67–70, 1 illus.

Die Oberflächenhärte von Kunstgläsern (Surface Hardness of Plastic Glass). H. Perkuhn. The surface hardness of several types of plastic glass was determined by means of the scratch test, at temperatures ranging from 0° to 45°C. From these tests it was concluded that there is a relation-

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ship between scratch hardness and tensile strength. It is stated that tensile strength may be determined from scratch hardness with a correctness of ±3 per cent. *Luftfahrtforschung*, December 8, 1943, pages 297–299, 7 illus.

Aircraft Woods. Edward W. Hudlow and Frank P. Davis. The characteristics of aircraft woods are discussed. A list of aircraft woods and their principal uses is given. The characteristics of glues used for aircraft repair are also shown in tabular form. A third table is devoted to the selection and properties of aircraft wood. *Aviation Maintenance*, May, 1944, pages 38–40, 148, 150, 152, 1 illus.

Impact Strength of Reinforced Plastics. Philip M. Field. A report is made of tests conducted by the Aeronautical Material Laboratories, Engineering Division, Naval Aircraft Factory. The tests were made to determine the impact strength of reinforced thermosetting plastics, to determine the effects of elevated and reduced temperature on their impact strength, and to compare the impact strength of plastic materials with those of aluminum and cast magnesium. The materials tested included phenol-formaldehyde and special resins reinforced with cotton, paper, asbestos, wood or glass in various forms. It is concluded that phenol-formaldehyde and other thermosetting resins with suitable reinforcing materials can have single-blow impact strengths equal to aluminum or magnesium. The reinforcing agents producing the highest impact strength of those tested were glass and cotton cords. Tables give detailed figures on the results of the tests. *Modern Plastics*, April, 1944, pages 123–125, 162, 2 illus.

Postwar Aviation

When Peace Comes to Aviation. Clare Boothe Luce. The Congresswoman from Connecticut states the case for an American air policy of "sovereignty of the skies" as opposed to "freedom of the air." She strongly urges that plans be made now for the United States' postwar international air-commerce program and states that, instead of the increasing militarization of American transport services, it is the duty of Congress to consider at once ways and means by which the United States' overseas civilian airways may be rehabilitated. Noting America's existing air policy, as well as the principles advocated by the British, she claims that "sovereignty of the skies" is essential to national defense. She also attempts to prove that international civil air supremacy for the United States is consistent with the best interests of world peace. In making her points, Mrs. Luce draws an analogy between marine shipping and air transport, showing that the American merchant marine suffered as a result of "freedom of the seas" policies, and predicts that America's leadership in international civilian air transport routes as established before the war, will meet with a similar fate under "freedom of the air" policies. *Aero Digest*, April 15, 1944, pages 54, 55, 210, 212, 214, 2 illus.

The Air Must Be Free. Elbert D. Thomas. In his advocacy of "freedom of the air" as a means of preventing further wars, the United States Senator from Utah proposes that certain specified areas over which he believes unrestricted airways should be established. He suggests, first of all, that there be certain free-air cities or free-air islands. He explains that by "free" cities he means cities that permit entrance and exit of planes of all nations without any reference to reduction of restrictions with regard to trade or immigration. He goes on to specify that unrestricted passage should be extended to aircraft on routes over the poles, the countries of the Axis powers and all their satellites, such internationalized rivers as the Rhine and the Danube, all mandated territories, over countries now occupied by the enemy, all land taken from the enemy countries and restored to their former owners, and the oceans. *Flying*, May, 1944, pages 51, 153, 1 illus.

Aviation and the Future. R. E. Whitmer. The prospects for postwar aviation are considered in sections dealing with the increase in the number of passengers to be carried, the future market for private planes, technical improvements that must be made, future air-mail possibilities, the cost of air transportation, and the plane of tomorrow. *Mechanical Engineering*, May, 1944, pages 315, 316, 320.

Down to Earth on Postwar Planning. Lee N. Brutus. Some observations with regard to potential postwar markets for aircraft. The writer believes that, while there will be a large demand for cargo and passenger liners immediately following the termination of the war, the demand for private airplanes will be a moderate one with a normal, gradual growth. Postwar buyers of private planes are divided into five definite classes; the possible volume of sales which may be expected from each class is discussed. These divisions consist of: (1) present and past owners who will want new equipment; (2) returning military pilots, crews, and mechanics; (3) corporations and others desiring private planes for business purposes; (4) boys who have had preflight training, especially if the Army-sponsored program of the Civil Air Patrol gets into full operation; (5) the general public. Of these, the fourth is designated by the writer as the greatest potential source of sales for postwar personal airplanes. *Western Flying*, April, 1944, pages 228, 230, 232, 1 illus.

A Preface to Postwar Planning. George E. Haddaway. In this third article of a series on postwar aviation planning the writer decries the United States' lack of definite policy with regard to international aviation. He criticizes the probable appointment of nonaviation delegates to a United Nations conference on global air transport, and denounces the fact that all-inclusive discussions among accredited aviation experts in the United States have not been sponsored to develop the fundamentals of an international aviation policy for this country. He also summarizes several pertinent questions that must be answered in determining just what that policy will be. These are: (1) What type of agency or agencies will the United States provide to engage in foreign air transport? (2) Shall the United States pursue a policy of "freedom of the air" and, if so, just what constitutes "free air"? (3) Should operating rights into foreign nations be negotiated between this nation and foreign countries individually or should an international aviation-control body, guided by the United Nations, decide and officially assign such operating rights?

The article includes comment on the agenda for postwar planning recently released by the Senate Commerce Committee's aviation subcommittee. It recommends that everyone interested in the subject of aviation planning read this document. *Southern Flight*, April, 1944, pages 38, 52.

Needed: A Merchant Marine of the Air. Keith Ayling. Plans for the postwar utilization of the flying personnel of the armed forces and skilled aircraft workers are suggested. A warning is given against a repetition of the mistakes in policy following the first World War, under which aviation was allowed to deteriorate. Because there are now so many more people who have become skilled in the various branches of aviation, broad plans must be made to avoid loss of the benefits of their knowledge and experience. An attempt is made to estimate the peacetime market for aircraft and air transportation. Reference is made to a statement by the British Merchant Air Service Advisory Council suggesting the formation of a merchant marine of the air and a national aeronautical university to train personnel for the air lines of the future. It is stated that the United States needs a similar plan and that every person engaged in military aviation should be given an opportunity to register for work in aviation after the war. The writer proposes that plans be made for a period extending far beyond the postwar years, so that a steady flow of trained personnel may be developed to man the predicted air fleets of the distant future. *Air Trails*, June, 1944, pages 21, 64, 66, 68, 1 illus.

Manpower for the Mammoths. This article contains the admonition that plans for increasingly larger and more powerful postwar planes must be tempered by consideration of the physiological and temperamental limitations of the pilots who must fly them. It is suggested that the development of new and better means of safe flying, along with usage of moderate-size aircraft on the air services, be given precedence over the sponsorship of "hundred-ton" projects. With the

"SEAT-OF-THE-PANTS" FLYERS LAUGHED — BUT

Dick Merrill stayed with the Link!

Chief Link Trainer Instructor Harry Martin, of Eastern Air Lines, discusses recent improvements in the Link with Capt. Dick Merrill

When Eastern Air Lines standardized on Link Training for pilots in 1937, Capt. H. T. (Dick) Merrill had been flying the big "Silverliners" for eight years.

Merrill was quick to evaluate the remarkable ability of the Link Trainer to reproduce conditions of actual flight. He became an untiring student of instrument flying. His enthusiasm got a laugh from some flyers of the "seat-of-the-pants" school, but Dick continued to spend much of his spare time in the Link.

Now sixteen years with Eastern, Merrill has nearly three million miles to his credit. For the Military Transport Division of Eastern Air Lines, he has flown military personnel and materiel around the world. Among Merrill's feats are two outstanding records: *first* to fly the Atlantic Ocean both ways; *first* to fly the Atlantic round-trip with payload.

On the return leg of that round-trip flight to London, the weather was bad; with low ceiling, poor visibility, rain. Thanks to instrument flying skill, the crossing was "routine."

Dick Merrill has probably spent more time in the Link Trainer than any other pilot of his length of service.

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uncertainty demonstrated of choosing postwar transport pilots purely on their length of service, the best method is deemed to be through their selection by other experienced pilots who fly with them. *Flight*, March 30, 1944, pages 336, 337.

Private Flying

Are We Afraid of Cross-Country? William D. Strohmeier. Urging the private flyer not to be afraid of cross-country flights, the writer reasons that a long flight across the United States is nothing but a series of short hops. He indicates skill at map reading and practice in making landings on small and strange fields as two important requisites for proficiency in piloting a plane cross-country. Plans for aiding the navigation of such trips in the future are discussed. Among those mentioned are: Cessna's scheme for large pylons; the air-marking of towns; the establishment of airports at each community; and the building of air strips. In addition, the writer proposes that airway beacons might be made more prominent for daylight visibility and suggests certain specific improvements in aerial maps. *Air Facts*, May, 1944, pages 21–26.

Pity the Private Flier. George Reiss. In this article the writer makes a plea for less stringent private-flying regulations, wisely administered. It is stated that improved farsighted regulations will be necessary if the predicted boom in aviation is to be realized. Figures are quoted from a survey made for the office of the Secretary of Commerce to show the number of air certificates issued from 1934 to 1938. Comments are made about the performance of light planes, and anecdotes are related to demonstrate the difficulties under which private flying has been conducted in the past. *Air Trails*, June, 1944, pages 26–28, 86–88, 3 illus.

Dream Up Your Air Car. Leonard Angel. Accompanied by sketches of proposed airplanes for private flying after the war, an outline is given of the characteristics of the private airplanes of the future. Comments are made about existing types of light airplanes for private fliers, and performance characteristics that will be required in the future. *Air News*, May, 1944, pages 18–20, 70, 13 illus.

Is This the Solution? L. P. Sharples. The relaxation of existing regulations for private-flying certificates is advocated. The difficulties of the present examinations are reviewed, and it is stated that simplification will be necessary if private flying is not to be discouraged after the war. A new set of rules to accomplish these results is suggested. *Air Trails*, June, 1944, pages 29, 99–101, 1 illus.

Production

Methods for Forming Sheet Aluminum. Part I. First of a series of articles describing the techniques of sheet-metal forming. Practices advised are reported to be recommended by the Aluminum Company of America. This article deals with procedures of bending, flanging, beading, curling, crimping, hammering, and roll-forming. In outlining the operations involved in these processes, details are also included about the tools employed. The system of nomenclature adopted by the Aluminum Company of America for aluminum alloys is also noted. *Aviation*, April, 1944, pages 150–152, 276, 4 illus.

Hawker Typhoon. Part I. Wilfred E. Goff. First part of a continued article on the production processes employed by the Gloster Aircraft Company, Ltd., in the manufacture of the Hawker Typhoon fighter. This installment is concerned with the construction of the Typhoon wing and the manufacturing techniques employed in it. After briefly reviewing the development of the plan and its design features, the installment describes the construction of the wing and spars. It gives particulars on the machining of the spar booms, as well as on spar, leading-edge, trailing-edge, and wing assembly. It also covers the first fixture stage, the skeleton stage, the final fixture stage, wing finals, and the undercarriage-actuation test. *Aircraft Production*, April, 1944, pages 158–170, 28 illus.

Production Problems of Exhaust Collector Rings. Eric O. Johnson. An account is given of how the American Central Manufacturing Corporation adapted its extensive production equipment for die-pressing and deep-drawing such prewar articles as refrigerator cabinets and automobile-body parts to the quantity production of exhaust collector rings for aircraft. The need for collector rings was so urgent that time did not permit the construction of models, master layouts, templates, and assembly and detail drawings.

The article describes how a "hammered out" collector ring was used as a basis for the engineering, tooling, and production program. Machine tools developed and used for various operations are described. These include specially built expanders, pneumatic swagers, dies and fixtures, and a device resembling an alligator-type riveter used to flatten bolting flanges. *Automotive and Aviation Industries*, April 1, 1944, pages 24–27, 56, 8 illus.

Women Operate Mechanical Heat-Treating Department. Alex Ross. How women operate almost the entire heat-treating department of the Eclipse-Pioneer Division of Bendix Aviation Corporation. Conveyer furnaces speed the handling of parts in bulk. Control, which is centralized in the balcony, is largely automatic. Men handle only the extremely heavy operations. *Wings*, May, 1944, pages 1012–1015, 9 illus.

Corsair. A brief explanation accompanies illustrations of the use of three-dimensional perspective drawings in the work of assembling the Corsair. It is explained that these so-called exploded sketches enable semiskilled workers to visualize the process of making and assembling the parts of the plane, eliminating the need for training them to read and interpret conventional blueprints. However, the sketches do not take the place of regular engineering drawings in the design and manufacture of the airplane. The sketches show the relationship of each main part to the whole plane, as well as the relationship of the individual pieces to the make-up of the various subassemblies. *Life*, May 8, 1944, pages 41, 43, 44, 46, 11 illus.

Diversity Marks the Continental Line of Mechanical Rubber Products. Joseph Geschelin. A description of the manufacturing facilities and mechanical rubber products of an American rubber works. Molded, extruded, and die-cut rubber products for aircraft are listed and discussed. *Automotive and Aviation Industries*, April 1, 1944, pages 28–30, 74, 6 illus.

Design and Production Technique. A. J. Schroeder. Principles involved in punching are described and illustrated in this, the third of a series of articles. Particular attention is given to economical manufacture and correct design. Operations discussed include bending, rolling, embossing, planishing, and coining. *Aircraft Engineering*, March, 1944, pages 83–88, 103 illus.

Bending Preformed and Extruded Sheet-Metal Sections. Thomas T. Tobin. The writer describes the use of wrap-forming and cam-bending machines to give proper contours to airplane structural members made of extruded and preformed shapes. The special tools required for each type of work are described, as well as the operation of the machine. Specifications for the shapes that can be made are tabulated. Illustrations are shown of parts that can be formed by the cam-bender and wrap-bender. Parts that cannot be formed with these machines are illustrated in conjunction with a discussion of the capacities and limitations of the machines. *Machinery*, April, 1944, pages 139–145, 7 illus.

Stretch-Forming Double-Curved Sheet-Metal Parts. R. B. Glassco and N. O. Myklestad. The second part of an article on the stretch-forming of sheet-metal parts with a double curve. It is devoted to a quantitative analysis of the buckling stress in a saddleback part formed from a sheet with an initial sag. *Steel Processing*, April, 1944, pages 222–224.

Quality Control. H. Howell. Three common misapplications of quality control to engineering production are reviewed. These are: (1) the practice of trying to determine control limits by

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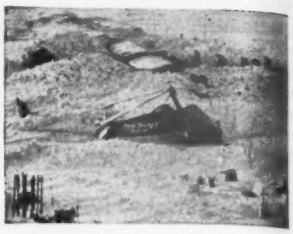

In 1933 a Kellett rotary wing ship accompanied Admiral Byrd on his South Pole voyage.

One of the Kelletts in Dept. of Agriculture use, for Dutch elm disease scouting, 1937.

Eastern Air Line's Kellett flew for a full year from Philadelphia's post office roof, 1938.

A flight of 1938 U. S. A. A. F. Kelletts performing in training maneuvers.

Most recent Kellett development (1943) for the Army Air Forces—YO-60 type.

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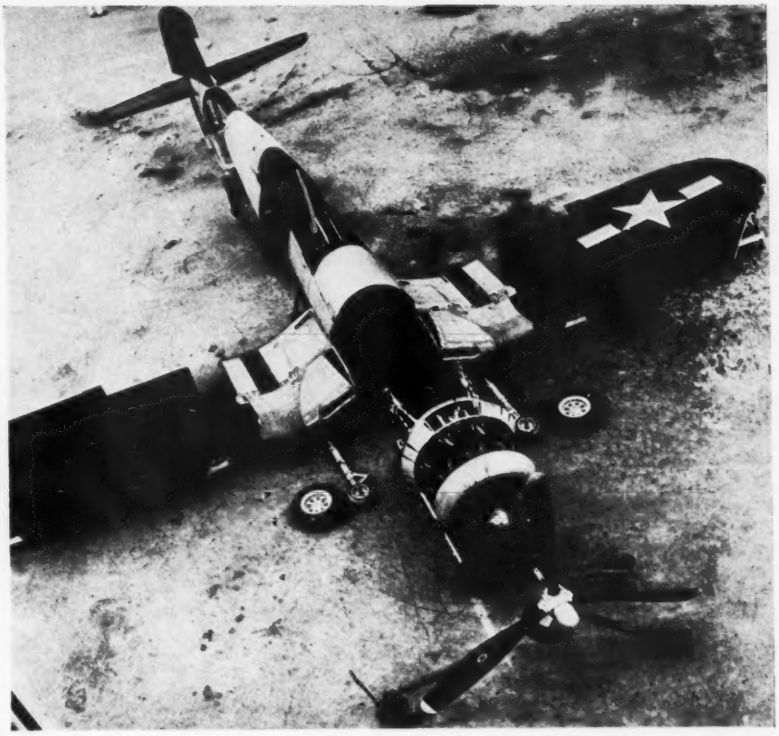
formula only; (2) the exclusive use of "Go" and "Not Go" gauges and, through their use, the determination of control limits by the parameter percentage defective; (3) quality control by means of the parameter percentage defective using "Go" and "Not Go" gauges made to control limits instead of drawing limits, as is the present practice. Demonstrating wherein the misapprehensions lie, the writer reiterates the advice contained in a previous article on quality control—that the system should be viewed less as an inspection check upon the product than as a determinant of and a check upon the stability of the process. *Aircraft Production*, April, 1944, pages 198–201.

Forming Properties of Vulcanized Fiber Sheet. C. A. Hedges. Details are given of a series of tests conducted to determine the forming and drawing properties of vulcanized fiber sheet. Rules for the forming of vulcanized parts for aircraft, established from these tests, are listed. *Automotive and Aviation Industries*, April 1, 1944, pages 40, 64, 1 illus.

Industrial Cooling as a Production Aid. J. Partington, Jr. A résumé of some of the newer applications of industrial cooling equipment. Brief reference is made to the testing of aircraft parts under extremely low temperatures and low vacuum. It is noted that the field of stratosphere testing is a large and complex one, offering a challenge to the best heat-transfer experts. *Heating and Ventilating*, April, 1944, pages 47–51, 6 illus.

Urgency of Timely Ordering of Aircraft Steel Forgings. Aircraft manufacturers are advised as to how they can help facilitate the satisfactory delivery of steel forgings by forestalling time-consuming changes in forge-shop schedules. It is suggested that they: (1) extend purchase order to the full extent of all contracts; (2) indicate, wherever possible, what forgings will be needed beyond present contracts; (3) check—in case of prime contractors—the ordering procedures of subcontractors; (4) set up proper inventory and material controls to insure that clerical erorrs do not cause changes in requirements; (5) confirm all verbal instructions by letter; and (6) allow forge shops sufficient flow time. The four programs by which the Aircraft Scheduling Unit of the Aircraft Production Board is attempting to relieve critical shortages of aircraft steel forgings are outlined, and accompanying charts indicate the necessity for immediate placement of forgings orders if 1944 requirements are to be met. *Aero Digest*, April 1, 1944, pages 91, 92, 1 illus.

Republic Uses Penetrating Process. A brief article describes the process of surface treatment of small-aircraft-engine parts at the Republic Aircraft Products Division of the Aviation Corporation. The purpose of the process is to improve the antifriction element of the parts. The process is not deep impregnation, but merely coats the part with an oxidized film. The six tanks and the solutions used in them are described, as well as the steps and time required in the process. *The Iron Age*, April 13, 1944, page 65, 1 illus.



A mock assembly of the Vought Corsair shows how final assemblies arrive for mating on the final production line.

Repair Techniques for Salvaging Airframes. R. L. Schleicher. Stating that the problem of salvaging airframes found defective during the process of manufacture has been a matter of concern to all manufacturers, the writer proceeds to describe repair methods that have proved successful. Ten points that should be observed in analyzing damage to a part are listed. Sections of the article deal with sheet-metal repairs, rivets and riveting, stringer repairs, and the inspection of bolted joints. *Automotive and Aviation Industries*, April 15, 1944, pages 32–34, 74, 76, 78, 3 illus.

Determining Tool Efficiency in High-Speed Milling. Wallace E. Brainard. This article describes the development of a simple and accurate method of comparing and evaluating various designs of high-speed milling cutters for machining aluminum alloys. The loads are measured directly at the cutter and are evaluated in terms of material removed. The cutter holder is treated as a beam and an electric-type strain gauge is used to measure the applied load. Sections discuss measuring the cutter load, measuring the tear of the chip, and evaluating milling cutters. *Mechanical Engineering*, May, 1944, pages 301, 302, 10 illus.

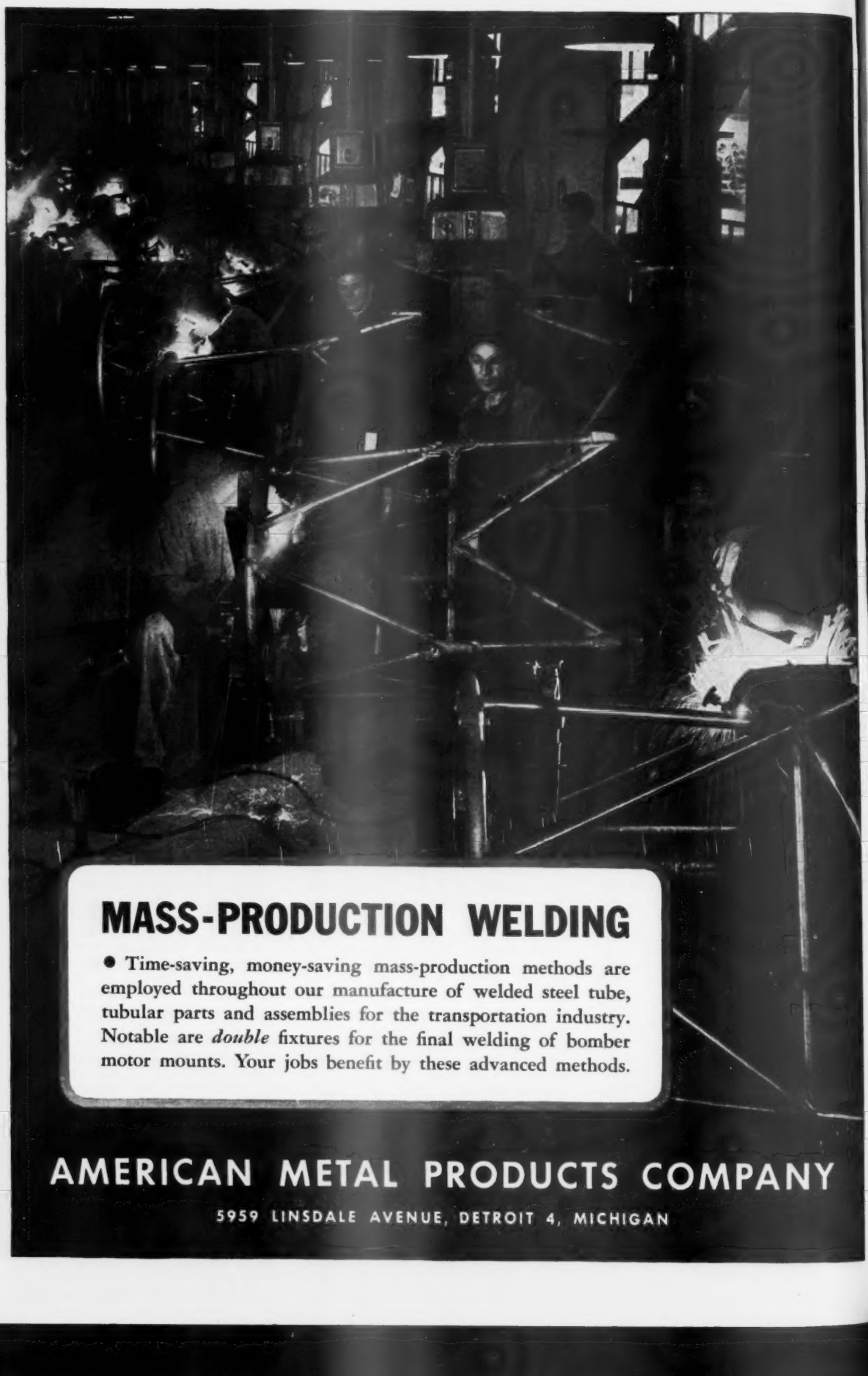
Isometrics Help Explain Assembly. James H. Bartholomew. A description of the way in which the Sperry Gyroscope Company uses simplified production illustrations to make jobs easy to understand. *Wings*, May, 1944, pages 1016, 1017, 4 illus.

Production of Stainless Steel Exhaust Manifolds at Buhl Stamping Company. W. N. Robinson. An account of the way stainless-steel exhaust manifolds for aircraft engines are being manufactured on a quantity production basis to meet war demands. The article tells how stampings are produced on hard dies and describes cleaning, welding, sandblasting, and final inspection operations. *Steel Processing*, April, 1944, pages 213–216, 7 illus.

Hills-McCanna Foundry Devoted Entirely to Magnesium Castings. Joseph Geschelin. The technique of an organization that specializes in the production of magnesium-alloy castings is revealed in this article. It is noted that at present the company is producing a large variety of magnesium castings for military aircraft, including such items as carburetor-throttle bodies, landing-gear wheels, blower sections, wire-harness rings, brake parts, camera frames, and parts for gun turrets, gun controls, and air frames. The article describes how difficult magnesium-casting problems are being solved by improved foundry methods. *Automotive and Aviation Industries*, May 1, 1944, pages 30–32, 90, 6 illus.

Propellers

Fabrication of Hollow Steel Propeller Blades. This article describes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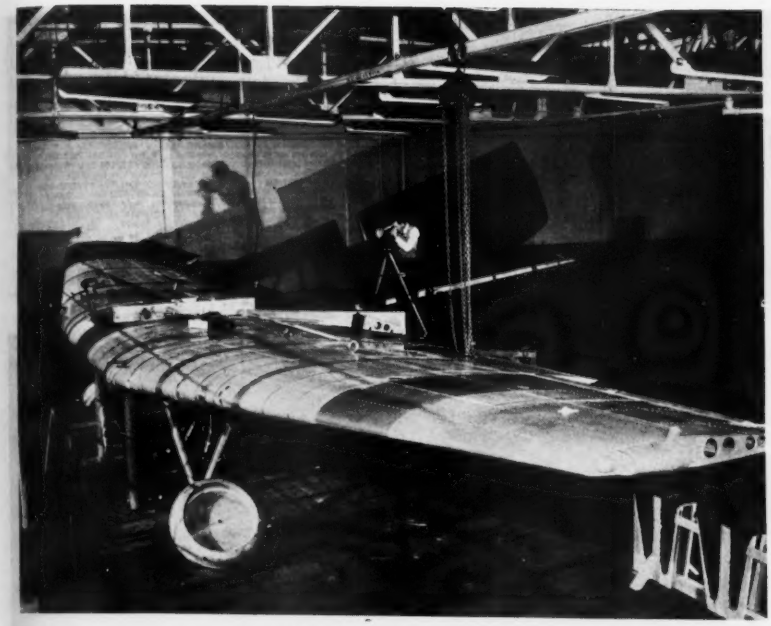


Pin-point accuracy is required in checking the alignment of wings and the machine guns fitted into them at the Tarrytown, N.Y., plant of Eastern Aircraft Division of General Motors Corporation. Workmen here are checking wings to go on an Avenger torpedo bomber.

the process used in the manufacture of hollow steel propeller blades. It is based on information supplied by the Curtiss-Wright Corporation and The International Nickel Company. Sections of the article discuss pressing, welding, swaging and upsetting, brazing, and heat-treating. Other sections describe balancing, polishing, surface finishing, and final inspection operations. *Steel Processing*, April, 1944, pages 228–231, 243, 8 illus.

Metal Propeller Service. Ed. Packer. Correct methods of repairing metal propellers are illustrated in this description of what was seen in a tour of a shop located at Sky Harbor Airport, Northbrook, Illinois. *Aviation Service Magazine*, March-April, 1944, pages 14–22, 28, 18 illus.

Radio

"Ultra High" on the Airways. Fred Hamlin. An outline of the advantages attendant upon the change-over to ultra-high-frequency radio for transport use on United States airways is supplemented by a brief review of the history of ultra-high-frequency development for aviation. Notes are included about the Army's recent release of equipment for air-line use; the ranges covered by the different radio frequencies; the C.A.A.'s program for overall conversion to ultra-high-frequency in the United States; the obstacles to using ultra-high-frequency for international air transport; and improvements in low-frequency operation which indicate that this system is not to be neglected for the development of ultra-high-frequency. The advantages cited for ultra-high-frequency radio ranges for aviation are that thunderstorm static will be eliminated; precipitation static will be reduced; it will operate in a much less crowded frequency spectrum; and it will give better course definitions and have fewer multiple courses. *Flying*, May, 1944, pages 43, 160, 162, 1 illus.

Enemy Army Communications Equipment. Major Gen. Roger B. Colton. In a general analysis of captured communications equipment, descriptions are included of the communications equipment taken from enemy airplanes. The first enemy equipment to be analyzed by engineers of the Signal Corps was the air-borne FuG 10 radio communications set used in German bomber and reconnaissance aircraft, such as the Junkers 88 and the Heinkel 111. The complete set consists of a long-wave transmitter and receiver, a short-wave transmitter and receiver, direction-finding equipment, intercommunication amplifiers, blind-approach equipment, and associated dynamotors and control boxes. These are described in considerable detail, and a similar analysis is given of the latest type FuG 16Z sets installed on recent bombers and fighters. The Notsender NS 2 sea-rescue set is also briefly mentioned, and the comment is made that German air-borne electrical equipment, in general, is sound but not advanced. The quality and workmanship are excellent, the design facilitates servicing, and standardization has contributed to quantity production.

A similar analysis is made of Japanese equipment. The receiver, transmitter, and dynamotor removed from a Zero fighter are stated to be of crude construction and to include either inferior American materials or replicas of them. The latest radio-communication set received—the model 99, type 3, removed from a type 97 bomber—is described as being of somewhat better construction and workmanship, but the design is not so advanced as American and British practice. Analysis of Japanese and German ground communication equipment is also included in the review. *Electrical Engineering*, April, 1944, pages 139–144, 16 illus.

Approach to the Problem of Radio Precipitation Static. Part I. C. J. Breitwieser. Beginning of a two-part study on the cause for, and the cure of, precipitation static. In this section a new theory on the origin of the phenomena is advanced and explained as follows:

As an airplane flies into a region of precipitation, the electrons of particles striking the surface of the airplane (from the outer orbits of the atoms which make up the molecules) are disturbed, and a small percentage of them are disassociated to such an extent that they remain on the metallic surface. The continued striking of the surface by thousands of precipitation particles soon builds up an observable charge on the metallic body. The particles, after leaving one or more electrons, are then left with an excess of positive charge. These positively charged particles are swept away by the slipstream into the region to the rear of the airplane. Here they eventually recombine with free charges that may exist in the atmosphere. It is stated that probably many of the positively charged molecules recombine with the electrons that flow from the corona discharge of the airplane.

The explanation is preceded by a brief account of the manifestations of precipitation static and the factors tending to increase its presence in aircraft radio. Commercial air-line experiences in combating this problem are reviewed, and the conditions under which the trailing-wire static discharge and shielded loop antenna do not function are pointed out. *Aviation*, April, 1944, pages 142–144, 243, 245, 247, 249, 4 illus.

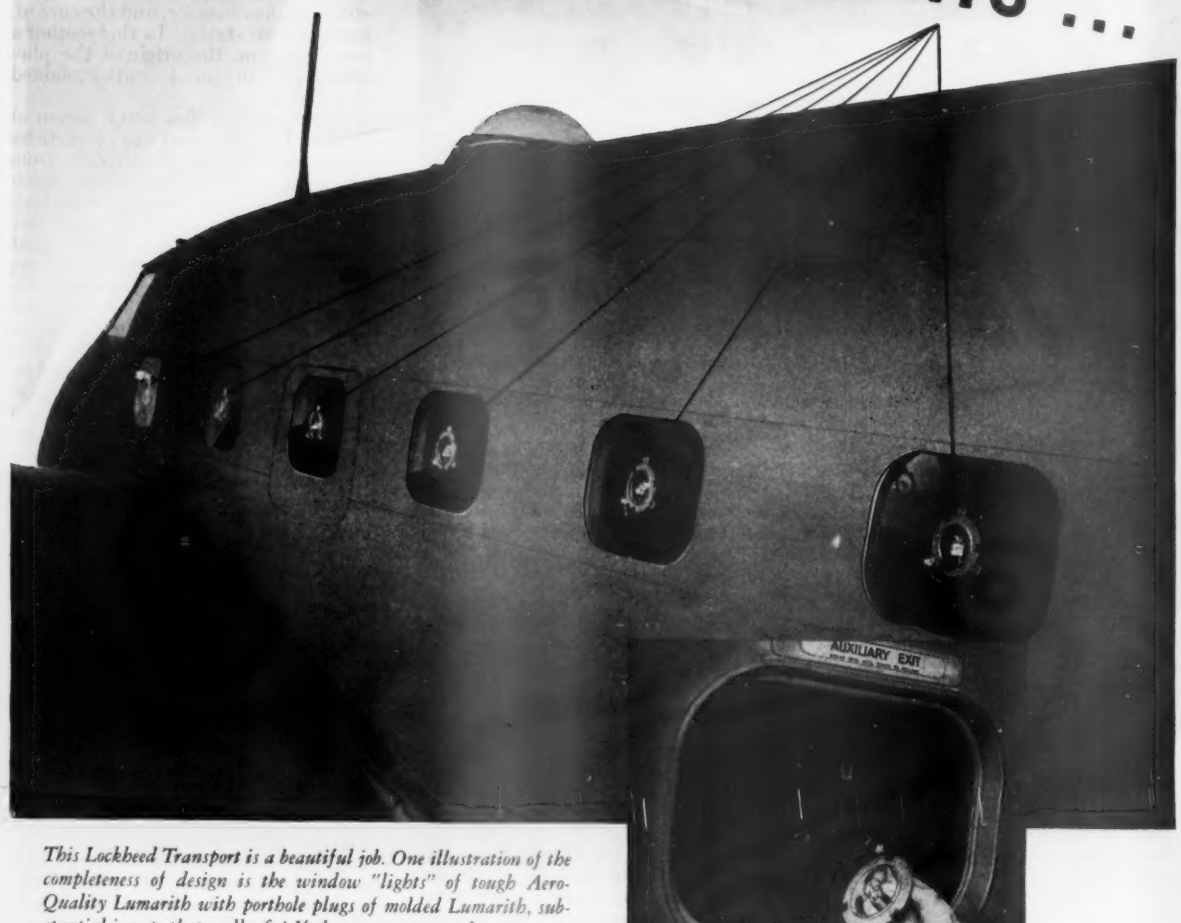
Radio in the R.A.F. A series of notes on the wireless and radio equipment used by the Royal Air Force. Operational requirements for such equipment are noted. Some general details are given on the wireless telegraphy and radio telephony sets used, and the application of mobile radio equipment for "second front" requirements is discussed. *Flight*, March 9, 1944, page 257.

Emergency Radio Servicing. Lt. Col. J. G. Tustison. This is a summary of short-cut methods for locating trouble in aircraft radio and electronic devices. General servicing hints are given, as well as information about impedance measurement, testing of transmitters, and signal tracing. *Air Tech*, May, 1944, pages 60, 62, 6 illus.

Reconversion

Planning for Postwar Planning. D. E. Browne. The writer offers his

For shooting out the "LIGHTS"...



This Lockheed Transport is a beautiful job. One illustration of the completeness of design is the window "lights" of tough Aero-Quality Lumarith with porthole plugs of molded Lumarith, substantial inserts that really fit! If the enemy gets too close, out come the Lumarith ports and the boys take a few pot shots.

Here is an application that shows Lumarith doing business in two forms. The windows are Aero-Quality Lumarith sheets—the high impact strength transparent plastic developed for aviation use. The ports are molded from Lumarith molding materials.

The general toughness of Lumarith and its ability to withstand torque have strong appeal to aircraft designers. To make full use of this quality, some interesting designs are on the board. If you haven't received a copy of the second edition of Lumarith Mounting book giving data on the subject, send for a copy. Celanese Celluloid Corporation, The First Name in Plastics, a division of Celanese Corporation of America, 180 Madison Avenue, New York City.

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suggestions for the orderly termination of contracts for war materials and the reconversion of plant facilities to the production of civilian goods. A four-point program is outlined as follows:

(1) Government obligations must be paid promptly when war contracts are terminated; (2) we must have a Government program for control of the disposal of surplus supplies and equipment; (3) we must have a program for the disposal of Government-owned production equipment, so that Government will not compete with private industry; (4) we must have a program that will permit manufacturers to build cash reserves now to meet postwar reconversion needs. The foregoing program is offered as a prelude to postwar planning, and the individual topics are discussed in considerable detail. Reference is made to testimony given before the House Committee on Military Affairs and to suggestions offered by the American Institute of Accountants. *Air Trails*, June, 1944, pages 17, 92–94, 1 illus.

Rotating Wing Aircraft

A Jet Propelled Helicopter. Features of the Pullin-Weir patents for a jet-propelled helicopter are described. These patents, filed in Great Britain, relate to a helicopter in which the rotor is driven by jet reaction applied to the blades. A gas-stream power unit delivers gas and air at a high temperature to the hollow mounting member and hub of the rotor. From there, they are carried through channels in the interior of the blades to an orifice at the trailing edge of the blade tip and expelled with or without an additional intake of air to increase the stream. There is no mechanical drive of any kind for the rotor and practically all control is vested in the rotor. The design also utilizes jet-reaction nozzles for mass-balancing the rotor blades. *The Aeroplane*, May, 1944, page 279, 2 illus.

Looking Ahead with the Helicopter. David J. Little. Discussing the future of the helicopter, the writer states that the helicopter of tomorrow will be offered an immensely wider field of usefulness than that afforded the automotive vehicle of today.

The way in which helicopters are operated and controlled is explained. Advantageous characteristics of the helicopter not passed by the autogyro are mentioned, and improvements in helicopter design which may be expected to be made in the future are described.

It is stated that increased rotor efficiency will result in higher power loading and that the family-size helicopter will require an engine similar to that of the present family car. It is predicted that automatic lift control will render operation as simple as driving a car.

The future use of the helicopter as a public service conveyance is also discussed. *The Draftsman*, April, 1944, pages 23, 29, 48, 1 illus.

Bell Aircraft Corporation's two-place helicopter. The two-bladed rotor used makes possible a simplified hub design. The variable-pitch antitorque propeller at the tail has solid wood blades.

The Cameron Rotor Plane. Illustrated by photographs of a working model, data are given on the Cameron 4, a plane that is a combined helicopter, gyroplane, and orthodox aircraft. The design incorporates retractable rotor blades and variable-incidence wings and affords three possible modes of flight: as a pure helicopter, with rotor blades fully extended and wings tilted into a vertical position; as a gyroplane, with wings nearly horizontal and the rotor blades only partly extended; and as an ordinary aircraft, with the fixed wings carrying most of the load and the fully shortened rotor blades merely autorotating. Limitations, as well as advantages of the type, are discussed. *Flight*, March 30, 1944, pages 342, 343, 3 illus.

Stress Analysis

Strength of Light-Alloy Components. J. L. Beilschmidt. Following a discussion of the customary limitations imposed upon the use of light-alloy materials for aircraft structures, in which it is shown that it is not possible to utilize the full tensile strength of the metal, it is noted that alloys in this class are seldom used for structural members in pure tension. These alloys are more commonly used in the form of castings and forgings, producing components in which various stresses occur (particularly bending stresses). It can be shown that under the conditions mentioned the stipulated limitations are, in the main, not applicable. New conditions resulting from the introduction of the bending stresses are compared with the condition of pure tension and illustrated by stress-strain diagrams. Comparing conditions under which the stress-strain relationship is linear with cases in which the distribution is known to be nonlinear, the writer demonstrates a different method of calculation.

The foregoing examples having been based on a condition of symmetry of stress distribution, the writer then considers the effects of nonsymmetrical distribution. He develops mathematical methods for defining the neutral axis position for nonsymmetrical sections and for dissimilar material stress-strain tension and compression characteristics.

Two examples are given: In the first, it is necessary to calculate the moment of resistance to bending of an I-section through a magnesium-alloy beam of given dimensions; in the second, a beam of similar dimensions but made of cast-iron alloy is used. An appendix shows the method of determining the index of the stress-strain characteristic. *Aircraft Engineering*, March, 1944, pages 76–81, 8 illus.

Analysis of Stretch-Forming Double-Curved Sheet-Metal Parts. R. B. Glassco and N. O. Myklestad. In this paper double-curved surfaces, typical in airplane design, are classified according to direction of curvature. A qualitative stress analysis is made of stretch-forming each class of surface, with special reference to the stress transverse to the direction of restraint. It is shown that there are two distinctly different sources of transverse stress during stretching. The resultant stress may be tension or compression, depending upon the direction and amount of curvature. When the resultant transverse stress is compression, undesirable wrinkling of the sheet may occur. *Transactions of the A.S.M.E.*, April, 1944, pages 161–168, 21 illus.

Computing Load on Aircraft Engine Mount Rings. M. S. Simms. The writer presents a development of a general method for calculating loads imposed on the engine mount ring by an aircraft engine when the engine is mounted to the ring by several vibration absorbers placed around the cir-

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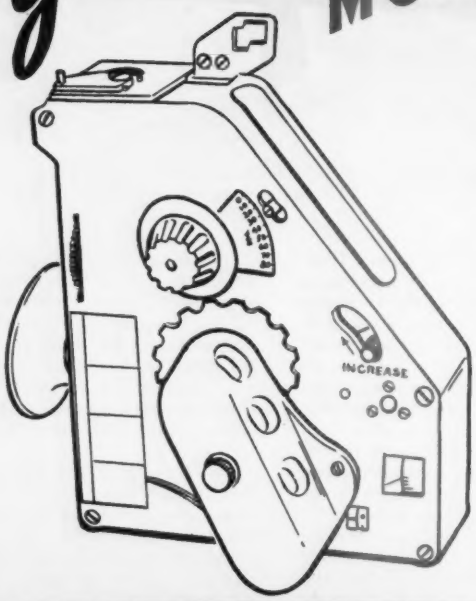


There's a job! Think of the steps involved. First comes engineering with research, for most successful machines are but the sum of previous efforts—plus improvements. Then a pilot model moving through experimental . . . but we are getting ahead of ourselves.

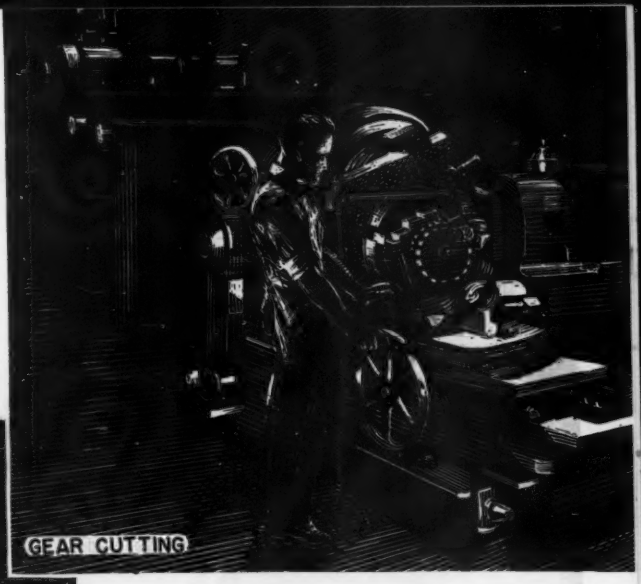
What we mean to tell you in this ad is that VARD INC. can build units like a Sextant from the drawing board to the finished model in quantity production and never go outside our own plant for anything except raw materials.

Getting back to the pilot model . . . we'd probably make several in experimental with very little tooling. After the design was thoroughly "shaken down," the item would be tooled for production in quantity. We would make a wood pattern for the chassis of the instrument, mould it in sand, and cast it of an aluminum alloy. Other parts would be cast in permanent moulds. Some parts would be stamped.

Inside the Sextant would be gears and ground parts, precision mirrors, and optical glass parts. There would be accurately machined and engraved dials, etc., of metal and plastic. We can do all that.

To make the instrument look right, and stand the weather, its parts would require anodizing, plating, and enameling. We do that, too!

Next, we'd make a wood, plastic, or metal carrying case. And finally—very important—we'd test the Sextant mechanically and optically—on our own equipment.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In all the hundreds of different operations necessary to complete the pilot models, we have the men and tools to do the job. But here's the thing that makes VARD INC. unique on the Pacific Coast, we also have the equipment and organization that can turn out Sextants in production.

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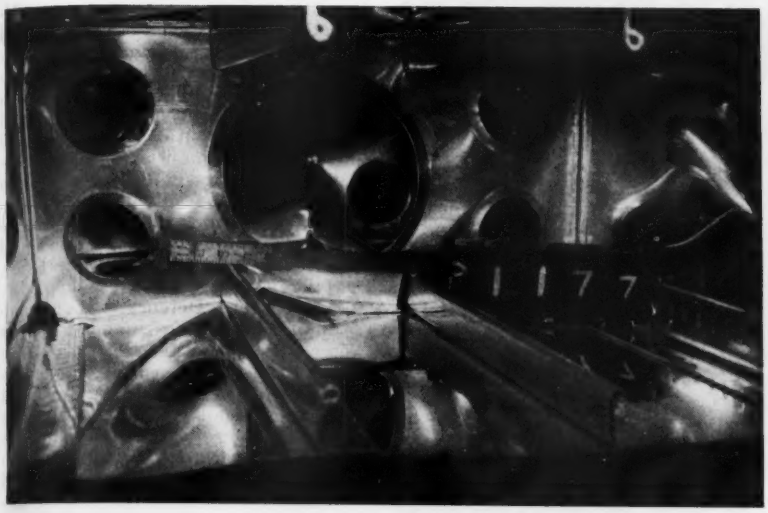


Results of a static torque test on a spot-welded ribbed-skin joint. Spots were torn from the joint after collapse. The spot-welded box had a 30 per cent greater torsional rigidity than that of a riveted box.

cumference of the ring, giving what is known as "dynamic suspension." The method is applicable to either the Wright system of suspension or the Pratt and Whitney system. *Automotive and Aviation Industries*, May 1, 1944, page 42, 2 illus.

Testing

The Conversion of Hardness Values. E. Skerry. The confusion caused by the employment of many types of hardness machines, each designed for meeting special requirements, is referred to. Factors that must be taken into consideration when converting one hardness value to another are discussed. *Aircraft Engineering*, March, 1944, page 89.

Endurance Tests Prove Quality of Gang-Riveted Joints. L. P. Spalding. Tests conducted by North American Aviation, Inc., led to the conclusion that gang-riveted joints, whether produced with or without paper backing, are entirely satisfactory and can be used in production. The tests are described. *Automotive and Aviation Industries*, April 1, 1944, pages 43, 133, 2 illus.

How to Use Manometers. R. E. Gould. The use of the manometer for determining the differences in static pressure between two locations in a circulating system is discussed. Four basic types of manometers for testing purposes are described. *Heating, Piping, & Air Conditioning*, April, 1944, pages 204–206, 4 illus.

Flash Weld Proof-Loaders. Weller Johnson. Proof-loading machines built by North American Aviation, Inc., for testing flash-welded control rods are described. The procedure followed in operating the machines is outlined. *Automotive and Aviation Industries*, May 1, 1944, pages 35, 152, 2 illus.

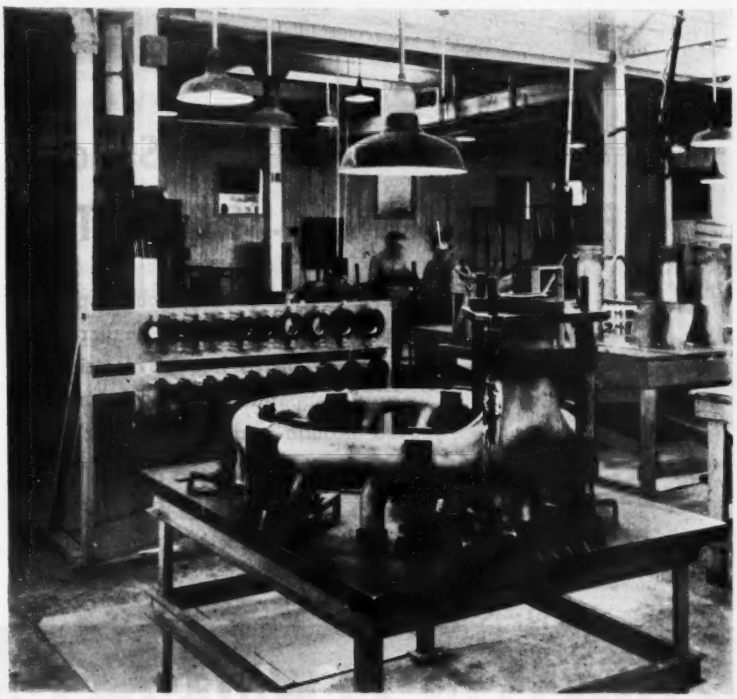
Tools and Equipment

Device Cleans Sludge Out of Crankshaft. A description is given of a tool developed for removing sludge from the inside of the crankshafts of Continental aircraft engines. Small bearing balls are whirled around with the cleaning fluid pumped into the passages, acting as hammers to chip away the hardened sludge. *Aviation Service Magazine*, March-April, 1944, pages 32, 33, 1 illus.

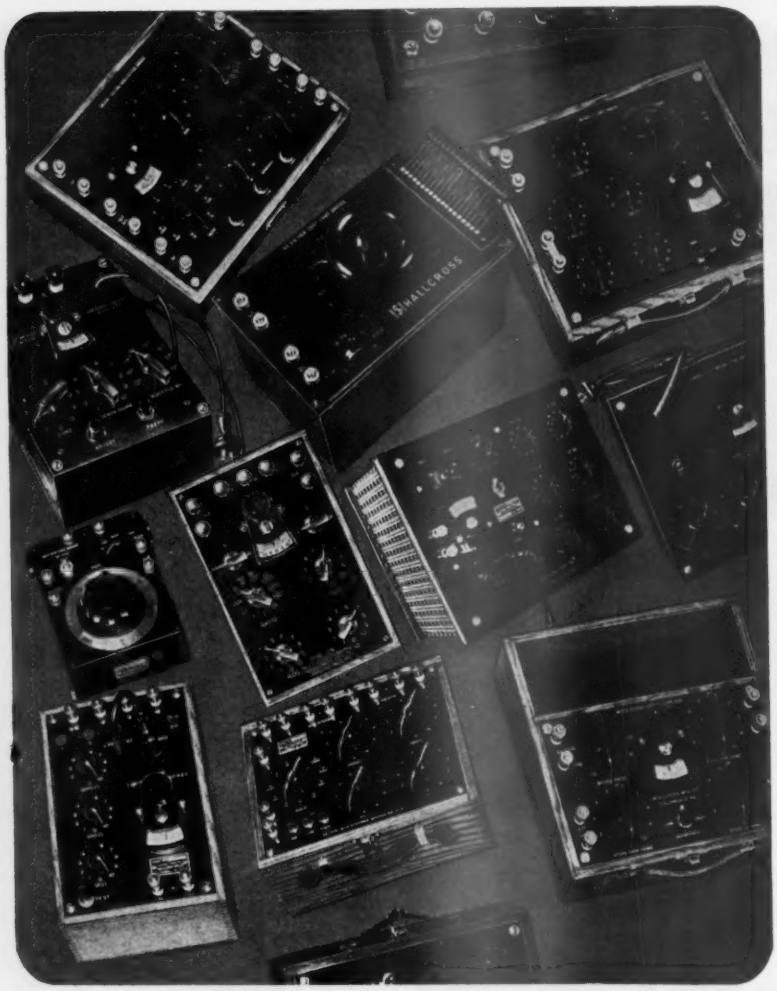
Training

Aeronautical Boondoggling. Don Valentine. Objections are raised to the continuation of Government-subsidized flight-training programs and preflight education, either in conjunction with regular high-school and college courses or through independent contractors. It is contended that military aviation training should be the responsibility of military schools, while the education of the general public should be left to competitive promotion by the aeronautical industry itself. The automotive industry is cited as a case where competitive sales and manufacturing methods have been the means of successfully educating the public to the use of the product, as well as creating a further demand for it. Present subsidized aviation training programs are indicated as being impractical and too technical for peacetime flight purposes. Arguments are based largely on the assumption that planes used by civilians will become increasingly safer and easier to fly. *Air Facts*, May, 1944, pages 34–38.

Bull's-Eye Aim Makes 'Em Bombardiers. Part VIII. The eighth article in a series about the schools of the U.S. Army Air Forces deals with the training of the bombardier, as exemplified by the Victorville, Calif., bombardier school. The subjects studied in 460 hours of ground-school instruction and in the course of 85 hours of actual flying time are outlined. *Aviation*, April, 1944, pages 178, 179, 277, 3 illus.



A master inspection fixture for aircraft-engine collector rings of the American Central Manufacturing Corp. is duplicated at Consolidated Vultee. It permits quick checking of every dimension of a finished collector ring immediately upon completion and before attachment to the engine, where the ring collects exhaust gases and conducts them to the turbosupercharger.



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Illinois Looks to Air Future as Affecting Every Branch of Learning and Instruction. Joseph F. Wright. Plans of the University of Illinois for extensive expansion of its air transportation courses are outlined. It is explained that the University has purchased 730 acres of land on which will be constructed a Class IV airport. Seven broad objectives of the aviation program are listed. Special courses in the legal aspects of aviation may be added if necessary. *Air Transportation*, April, 1944, pages 42–44, 1 illus.

Aerodrome Defence. A ground-training scheme for commissioned air crew personnel of the Royal Air Force is described. The course, under the jurisdiction of the R.A.F. Technical Training Command, is designed to instruct flying officers in the rudiments of ground warfare and tactics and to teach them how to lead men in ground defense. With its main object aerodrome defense, the training includes range practice with rifles and automatic weapons, battle drill, assault courses, organized games and lectures. *The Aeroplane*, March 17, 1944, pages 304, 305, 6 illus.

—And Safety. Leighton Collins. Suggestions are made for training techniques that would place the emphasis on safety in civilian flying rather than on old-time military techniques. The differences between military flying and private flying are pointed out. The suggestions are concerned with the functions and proper usage of the rudder; stall and spin practice; and experience in high-angle-of-attack flight, on-edge flight, and recovery of control. *Air Facts*, May, 1944, pages 51–56.

Mobile Training Units. G. E. Nistal. The Mobile Training Units program developed by the Army Air Forces Training Command is described. It is explained that the system involves the use of large roving vans, equipped with complete mock-ups and staffed by special instructors who visit the maintenance and repair men at their tactical bases. One of these mobile vans is illustrated and its features are described. *Air Tech*, April, 1944, pages 39, 78, 7 illus.

They Didn't Know It Was Loaded. Mort Weisinberger. An article on the "Weights and Balances" course given by the Army Air Forces Training Command School at Yale University. In addition to notes on the equipment, curriculum, and commissioned pilots who take the course, the article includes data on the importance of properly balancing plane loads and reasons for scientific, rather than haphazard, methods of loading aircraft. *Skyways*, May, 1944, pages 50, 53, 80, 4 illus.

Deck Landing Training. Based upon a visit to a British escort carrier where training operations were being conducted, an account is given of how Fleet Air Arm pilots are schooled in the procedures of deck landing. The sequence of aviation training periods leading up to deck-landing practice is

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Not only in tires and tubes but in the actual fabrication of wheels and brakes, as well, General Tire sees to it that the *Quality* is there. In its own metal products division, tail wheels, brakes and main landing gear wheels are built to rigid General Tire Top-Quality standards and up to A. A. F. specifications. In design—in manufacture—*in service*—General's products have proved their superiority. When you buy from General you are buying from the source that is known 'round the world for quality and safety—because *the performance is there.*

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briefly reviewed. The deck-landing training routine is described, the duties of the deck landing control officer are outlined, and British and United States deck-landing methods are compared. The article includes information about the activities of the commander on such a training ship and also gives data on several airplane types used for carrier operation. *The Aeroplane*, March 31, 1944, pages 356–360, 9 illus.

Tracking with the CAP. Lt. John C. McGee. A description is given of the hazardous tasks performed by the tracking service pilots of the Civil Aeronautics Patrol. The work of a tracking unit, which consists of training antiaircraft personnel in the use of equipment, is outlined. *Air Trails*, June, 1944, pages 32, 33, 62, 6 illus.

Warfare

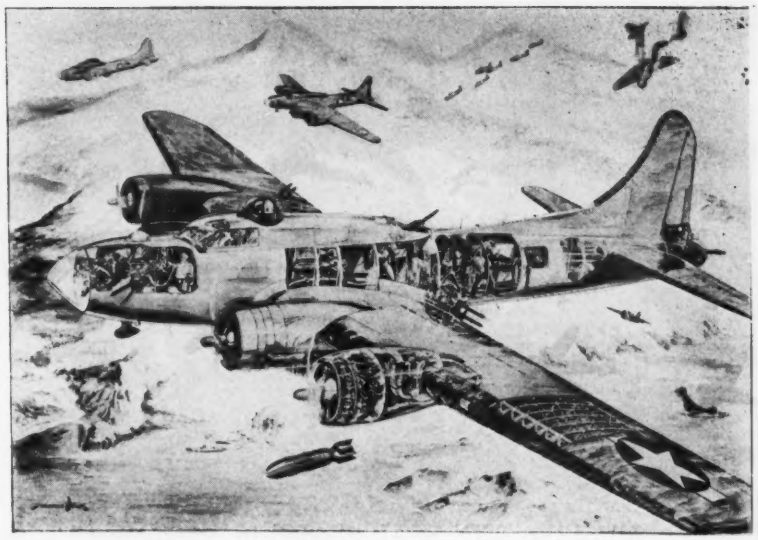
The Tactics of Turning. A. F. Tactical relationships between opposing aircraft or groups of aircraft are discussed. Information is given about the use of the shielding power of the sun in major tactics, and other factors connected with vision are discussed. How movements of individual aircraft in the air influence tactics is considered. The theoretical curve of pursuit is discussed with the aid of a diagram.

Included are discussions on altitude, range, speed, fire power, and air battle maneuvers. Comments are made about certain British and German fighter planes. Tabulations give data about the relative speed and weight of fire of the Spitfire and the Beaufighter and about the speed of travel of ordinary machine-gun bullets. *Aeronautics*, April, 1944, pages 50–54, 3 illus.

Welding

Spot Weld Joint Efficiency. D. Wong and C. W. Steward. Because the type of joint pattern, the method of surface preparation prior to welding, and the many variables involved in the spot-welding process are factors contributing to the effectiveness of the multispot joints of aluminum alloys, a detailed analysis of these factors was made. The welding equipment used is described and an outline of the test procedure is given. Subjects discussed include the significance of wire-brushed surface preparation, tests of sheet efficiency, spot spacing and joint patterns, chemically cleaned specimens, low *vs.* unit spot strength, variations in current wave form, a.c. welds, tip contour, and weld pressure. Some suggestions for further research are made. *The Welding Journal*, April, 1944, pages 170-s–184-s, 17 illus.

Elimination of Overhead Welding. An account of how the General Aircraft Company eliminated the overhead welding position in its glider-fabrication procedures through the redesign of jigs. The new design calls for the removal of the jig's legs and the suspension of its frame at two opposite points, between two supports, so that it can be rotated. This permits all the joints on one side of a subassembly to be welded in the flat position from above; then, when the jig is turned over, all the joints on the other side can be welded from the same position. The adaptation of this practice to the manufacture of the CG-4A troop cargo glider is described, and consequent savings in time are noted. *Aero Digest*, April 1, 1944, pages 74, 126, 2 illus.



A cutaway view of a Flying Fortress illustrates duties of the crew in action. In the nose the bombardier is releasing his bombs and the navigator and engineer are busy with their guns. The pilot is shown watching for enemy planes similar to the Zero going down in flames in the background; to his right is the copilot. The top turret guns, manned by another engineer, are primed for action. Next come the bomb racks, and then another top gun operated by the first radio operator against targets of opportunity coming in from above. The second radio operator mans the ball turret against underneath attacks. The two waist gunners, also the radio operators and engineers, man the 0.50-caliber machine guns. The retracted tail wheel can be seen next and then the tail gunner waiting for an enemy plane to come within range of his twin "fifties." One of the four Wright engines that power the huge bomber is also shown cutaway, together with part of the wing.

Flash-Butt Welding. Parts 1, 2, and 3. J. H. Cooper, J. J. Riley, and J. C. Barrett. A three-part article discussing plastic welds made by flash-butt welding. Part 1 contains basic information for the making of quality welds. In Part 2 the writers illustrate good and bad design practice and make recommendations that are predicated on creating balanced sections in the vicinity of the weld. Part 3 describes techniques for controlling metallurgical changes around the heat-affected zone of the weld line and in the parent metal. Illustrations show defects found in flash-butt welding. The causes of these defects are indicated and remedies are proposed. *The Iron Age*, April 13, 1944, pages 60–65, 7 illus.; April 20, 1944, pages 79–84, 7 illus.; April 27, 1944, pages 48–54, 11 illus.

Distribution of Shear Strength of Spot Welds in Various Aluminium Alloys. R. F. Tylecote and Angela Lias, from the German of F. Bollenrath and V. Hauk. Part 1 of an article taken from *Zeitschrift für Metallkunde*. The article describes investigations made to determine how the distribution of the shear strength of spot welds is affected by welding conditions in different aluminum alloys. The work was undertaken in order to obtain a more exact understanding of the extent of distribution and the causes of variations in distribution.

This installment is devoted to introductory comments, a description of the subject of the investigations, and an outline of the methods used in conducting the experiments. A summary of weld properties and test results is presented in tabular form. The translators add brief comments criticizing certain aspects of the discussion. *Sheet Metal Industries*, April, 1944, pages 689–693, 704, 2 illus.

Design of Spot Welded Aluminum Alloy Aircraft Structures. Albert Epstein and H. O. Klinke. This third and concluding installment is concerned with the spacing of spots and the strength of spot welds. It is stated that there is no simple rule for spacing spots. The general rule given suggests that spots be so spaced that interspot buckling does not occur before the ultimate strength of the sheet stringer panel is reached. Applications of the rule, some failures in spot-welding operations, and tension and peeling forces are discussed. Strength tests and the apparatus used are described and results are tabulated.

The article concludes with a discussion of the numerous miscellaneous structural items on which spot welding can be used and a review of the applications in which the method is successfully employed. Advice is given for the planning of basic and detail design

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work. It is stated that tooling methods will improve, costs will be lowered, and the use of roller spot welding will increase when greater volumes of spot-welding work are undertaken. *Aero Digest*, April 1, 1944, pages 94, 96, 98, 120, 122, 7 illus.

Joint Fit-up and Backing Plates for Welding Magnesium. F. A. Wassell. After noting that one of the most important factors contributing to the greatly expanding use of magnesium alloys is helium shielded arc welding, the writer describes the joint fit-up and backing plates used in this process. It is stated that good fit-up of the work is of primary importance, especially when light gauges of metal are butt-welded by the free drop-down method. The importance of clean surfaces in magnesium welding is emphasized. *Automotive and Aviation Industries*, May 1, 1944, pages 34, 82, 2 illus.

Aluminum Welding with Liquefied Gas. J. V. Kielb. The use of propane gas as an alternate fuel for welding aluminum sheet metal and aluminum castings is considered. The writer describes the preliminary investigations during which the technique and procedure of handling propane for welding these parts were set up. It was found that gas pressures with propane differed slightly from those of hydrogen or acetylene. The gas pressures used for different diameters of tip orifice are listed. Propane welding procedure in the manufacture of superchargers for aircraft is outlined. *The Iron Age*, May 4, 1944, pages 67, 152.

Miscellaneous

Annual Review of Military Aircraft. Accompanied by descriptive data, photographs are shown of British, Canadian, and United States combat and noncombat military airplanes, German warplanes, and some Japanese types. This review also includes tables of specifications for Canadian, United States, British, and German combat aircraft. *Canadian Aviation*, April, 1944, pages 61–124, 135 illus.

16th Annual Directory of American Aircraft and Engines. This directory includes a compendium of American civil and military aircraft and aircraft engines, as well as an index of American aircraft manufacturers. In the section on military airplanes, photographs and three-view drawings are supplemented by compilations of all released data on each plane. The civil aircraft section does not contain illustrations but combines, in table form, information as to specifications and performance. The types covered in the table are planes that are still in service, although out of production. In the section on engines, both specifications and photographs are presented. The manufacturers' directory lists key administrative, engineering, and production personnel of aircraft, engine, and propeller manufacturers. *Western Flying*, April, 1944, pages 69–198, 167 illus.

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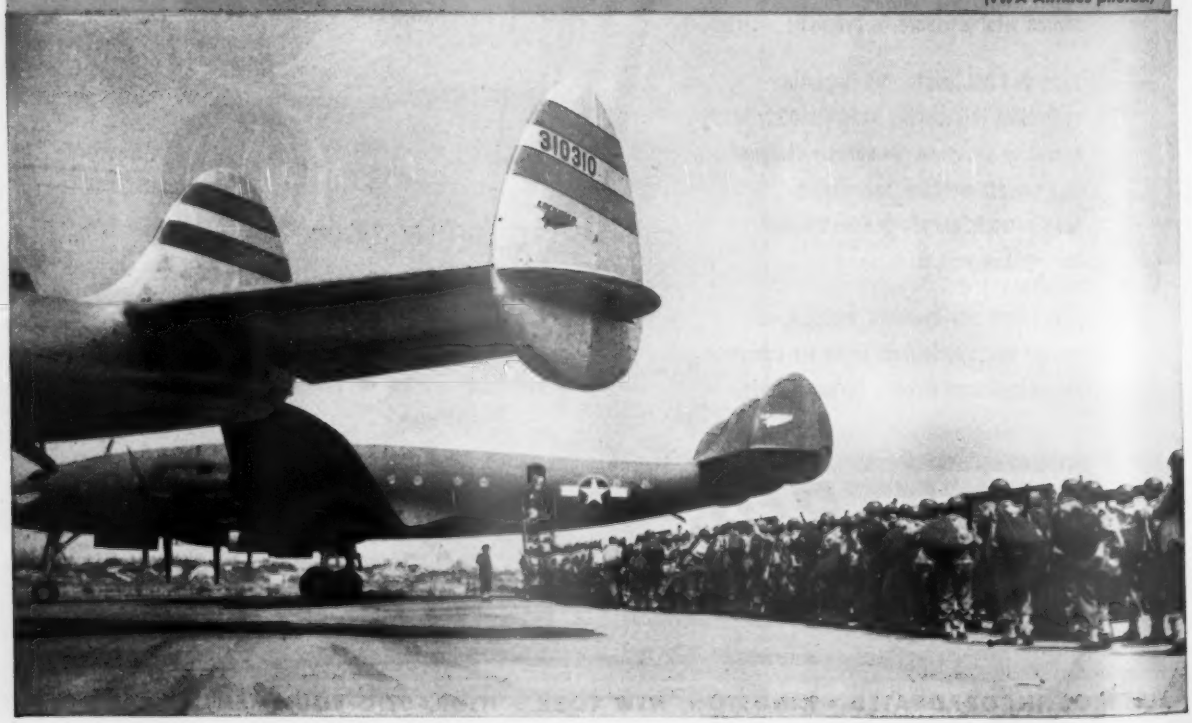
(Below) **A Constellation in military dress, takes aboard a load of soldiers.** *(TWA Airlines photos.)*



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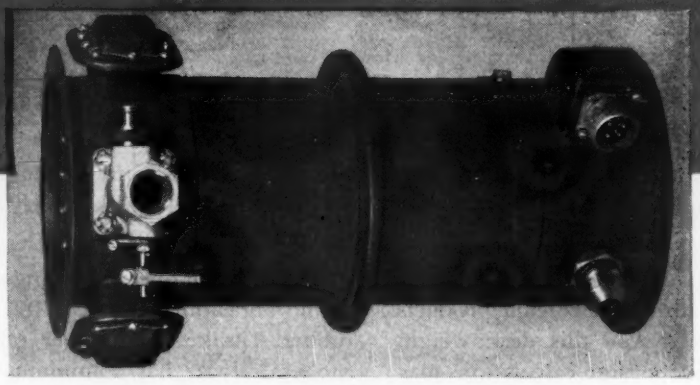

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Source Material

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The prices listed are for yearly subscriptions to recipients in the United States. Subscription prices to house organs are in many cases not available but may be obtained directly from the offices of the organization.

The AAFSATONIAN, School of Applied Tactics, Army Air Forces, Orlando, Fla.

The Ace-Pursuiter, Special Service Office, Paine Field, Everett, Wash.

Aero Digest, 515 Madison Ave., New York 22, N.Y., $3.00.

Aero News Letter, Aero Insurance Underwriters, 111 John St., New York 7, N.Y.

Aero Products, 271 Madison Ave., New York 16, N.Y.

Aero Research Technical Notes, Aero Research Ltd., Duxford, Cambridge, England.

Aero Time, Basic Flying School, Army Air Forces, Gunter Field, Ala.

Aerodrome Abstracts, compiled by the Department of Scientific and Industrial Research and issued in collaboration with the Air Ministry, The Institution of Civil Engineers. St. George St., Westminster, London, S.W.1.

Aeronáutica, Avenida de Mayo 1370, Buenos Aires, Pesos 4.50.

Aeronáutica Argentina, Casilla de Correo 1897, Buenos Aires, Pesos 8.00.

Aeronautical Briefs, Aeronautical Chamber of Commerce of America, Inc., 610 Shoreham Bldg., Washington 6, D.C.

Aeronautical Engineering Review, 1505 RCA Bldg. West, New York 20, N.Y., $3.00.

Aeronautics, Tower House, Southampton St., Strand, London, W.C.2, 26*s.* 6*d.*

The Aeroplane, Bowling Green Lane, London, E.C.1, 58*s.*

The Aeroplane Spotter, Bowling Green Lane, London, E.C.1, 8*s.* 8*d.*

Air Base News, Army Air Base, Jackson, Miss.

Air Currents, Army Air Field, Coffeyville, Kan.

Air Facts, 30 Rockefeller Plaza, New York 20, N.Y., $3.00.

Air Force, Army Air Forces, 101 Park Ave., New York 17, N.Y.

The Air Line Mechanic, 155 N. Clark St., Chicago 1, Ill.

The Air Line Pilot, 3145 W. 63rd St., Chicago 29, Ill.

Air Mail Magazine, Newport, Monmouthshire, 5*s.*

Air News, 545 5th Ave., New York 17, N.Y., $2.00.

Air Pilot and Technician, 515 Madison Ave., New York 22, N.Y., $3.00.

Air Tech, 545 5th Ave., New York 17, N.Y., $2.50.

Air Trails, 122 E. 42d St., New York 17, N.Y., $2.50.

Air Transport, 330 W. 42nd St., New York 18, N.Y., $5.00.

Air Transportation, 10 Bridge St., New York 4, N.Y., $5.00.

Aircraft Engineering, 12 Bloomsbury Sq., London, W.C.1, 26*s.*

Aircraft Journal, United Aircraft Corp., E. Hartford, Conn.

Aircraft Production, Dorset House, Stamford St., London, S.E.1, £1. 14*s.* 6*d.*

The Aircraft Warning Volunteer, First Fighter Command, Army Air Forces, Mitchel Field, N.Y.

Aircraft-Age, 241 Church St., New York 13, N.Y., $0.90.

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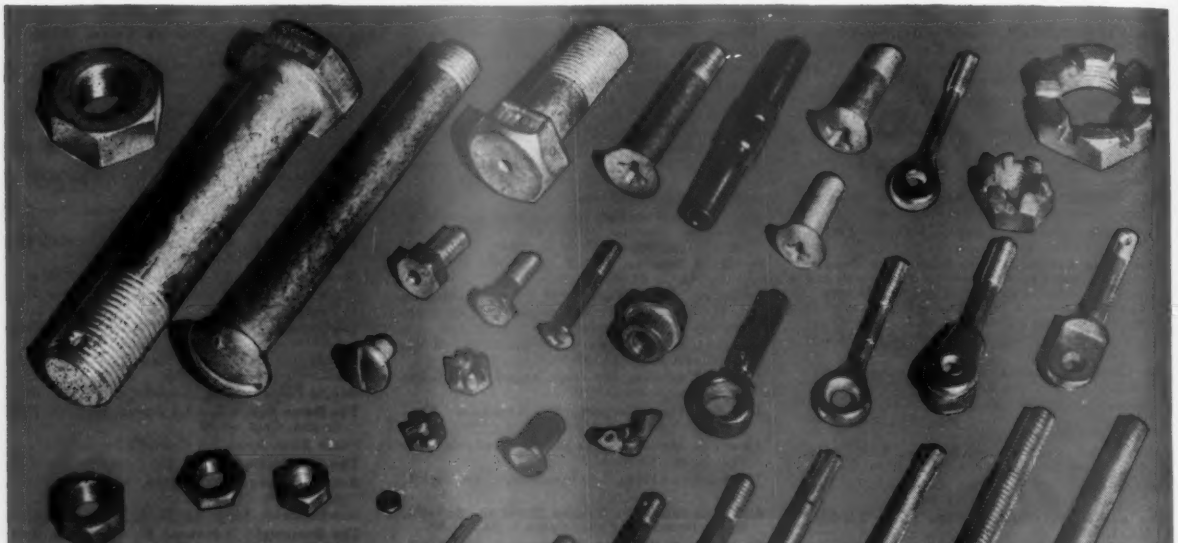

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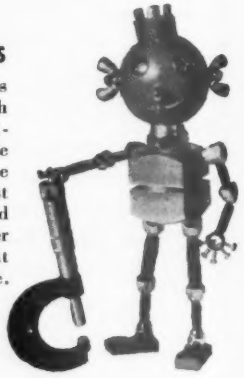

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Sheet Metal Industries, 3 Amersham Rd., High Wycombe, Bucks., 15s.

Shell Progress, Shell Oil Co., 50 W. 50th St., New York 20, N.Y.

Sheppard Field Texacts, Army Air Forces Technical School, Sheppard Field, Tex.

Simmonds Aeronews, Simmonds Aerocessories, Inc., 21-10 49th Ave., Long Island City, N.Y.

Sky Steps, Chicago and Southern Air Lines, Municipal Airport, Memphis 2, Tenn.

Skyfarer, General Aircraft Corp., 43-02 Ditmars Ave., Astoria 5, N.Y.

The Skyliner, Transcontinental and Western Air, Inc., Kansas City, Mo.

Skyways, 444 Madison Ave., New York 22, N.Y., $3.00.

The Slip Stream, Army Air Base, Casper, Wyo.

SNAFU, Eastern Flying Training Command, Army Air Forces, George Field, Ill., $0.05 per copy.

Snaproll, Pilot School (Basic), Army Air Forces, Minter Field, Bakersfield, Calif.

Soaring, P.O. Box 71, Elmira, N.Y., $2.00.

Sociedad Cubana de Ciencias Físicas y Matemáticas, Revista, Universidad de la Habana, Habana, Cuba, $3.00.

S.A.E. Accelerator; S.A.E. Journal, 29 W. 39th St., New York 18, N.Y., $10.

S.B.A.C. Press Summary, Society of British Aircraft Constructors, 32 Saville Row, London, W.1.

The Solar Blast, Solar Aircraft Co., Lindbergh Field, San Diego, Calif.

Southern Flight, 1901 McKinney Ave., P.O. Box 750, Dallas 1, Tex., $2.00.

Spartan School News, Spartan School of Aeronautics and Spartan Aircraft Co., Municipal Airport, Tulsa, Okla.

The Sperry News; The Sperryscope, Sperry Gyroscope Co., The Sperry Corporation, Manhattan Bridge Plaza, Brooklyn 1, N.Y.

The Stabilizer, The Lincoln Electric Co., Coit Rd. & Kirby Ave., Cleveland, O.

Steel Horizons, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

Steel Processing, 108 Smithfield St., Pittsburgh 30, Pa., $2.00.

The Stewart-Warner Worker, Stewart-Warner Corp., 1827 W. Diversey Pkwy., Chicago, Ill.

The Stinsonair, Stinson Division, Consolidated Vultee Aircraft Corp., Wayne, Mich.

Tac, Tactical Center, Army Air Forces, Orlando, Fla.

Tail Skid, Army Air Forces, Lawson Field, Ga.

Tailspin, Army Air Forces, Ellington Field, Houston, Tex.

Take-Off, Farris Publishing Co., Tinker Field, Okla.

Take-Off, North American Aviation, Dallas, Tex.

The Tale-Spinner, Army Air Forces Preflight School, San Antonio, Tex.

The Tarranter, Army Air Field, Ft. Worth, Tex.

The Taylorcraft News, Taylorcraft Aviation Corp., Alliance, O.

Technical Data Digest, Matériel Command, Engineering Division, Army Air Forces, Wright Field, Dayton, O.

Technical Education News, McGraw-Hill Publishing Co., 330 W. 42nd St., New York 18, N.Y.

Technical News Bulletin of the National Bureau of Standards, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., $0.50.

Texaco Star, The Texas Co., 135 E. 42nd St., New York 17, N.Y.

Texacts, Army Air Forces Technical School, Sheppard Field, Tex.

Thiokol Facts, Thiokol Corp., Trenton, N.J.

Thunderbird, The Rapid City Journal, Rapid City, S.D.

Timm Topics, Timm Aircraft Corp., 7801 Hayvenhurst Ave., Metropolitan Airport, Van Nuys, Calif.

Torque Tattle, Army Air Forces, Cochran Field, Ga.

Trade Winds, Wright Aeronautical Corp., Paterson, N.J.

Trade-A-Plane Service, Crossville, Tenn.

Transatlantic Air News, American Export Airlines, 25 Broadway, New York 4, N.Y.

True Drift, Army Air Forces, Selman Field, La.

Tucumán, Universidad Nacional, Revista, Serie A, Matemáticas y Física Teórica, Ayacucho 482, Tucumán, Argentina.

Tulsa Airview News, Douglas Aircraft Co., Inc., Tulsa, Okla.

The Twin Prop, Pilot School (Advanced Two Engine), Army Air Forces, Stockton Field, Calif.

The Twin Spinner, Army Air Field, Altus, Okla.

Twingine Times, Pilot School (Advanced Twin Engine), Freeman Army Air Field, Seymour, Ind.

United Air Lines News, United Air Lines Corp., 5959 S. Cicero Ave., Chicago 38, Ill.

U. S. Air Services, Transportation Bldg., Washington 6, D.C., $3.00.

U. S., N.A.C.A., Technical Memorandums, National Advisory Committee for Aeronautics, Washington 25, D.C.

U. S. Naval Institute, Proceedings, Annapolis, Md., $5.00.

U. S. Steel News, U. S. Steel Corp., 436 7th Ave., Pittsburgh, Pa.

Universal Airline Schedules, 139 N. Clark St., Chicago 2, Ill., $5.00.

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Upcheck, Lewis School of Aeronautics, Lockport, Ill., $3.00.

The Valve, Wilcox-Rich Division, The Eaton Mfg. Co., Battle Creek, Mich.

V.D.I. Zeitschrift, Edwards Brothers, Inc., 300 John St., Ann Arbor, Mich., $19.

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Vox Prop, Air Service Command, Army Air Field, Rome, N.Y.

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War Medicine, 535 N. Dearborn St., Chicago 10, Ill., $6.00.

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Warplane Production, Aircraft War Production Council, Inc., Hollywood Professional Building, Los Angeles 28, Calif.

Washington News Letter, 1025 Connecticut Ave., Washington 6, D.C., $2.00.

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Weight Engineering, Society of Aeronautical Weight Engineers, Inc., 143 N. Brand Blvd., Glendale 3, Calif., $1.75.

The Welding Journal, 33 W. 39th St., New York 18, N.Y., $5.00.

West Coast Air Mail Society, Bulletin, 4142 26th St., San Francisco 14, Calif.

Western Flying, 304 S. Broadway, Los Angeles 13, Calif., $2.00.

Wheelco Comments, Wheelco Instruments Co., Harrison & Peoria Sts., Chicago 7, Ill.

Williams Field Airfax, Army Air Forces, Williams Field, Chandler, Ariz.

Wing Tips, Army Air Field, San Bernardino, Calif.

Wing Tips, Pilot School (Specialized Two Engine), Mather Field, Sacramento, Calif.

The Wingfoot Clan, Goodyear Aircraft Corp., 1217 E. Market St., Akron, O.

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Wings, 1-5 Marion St., Wellington, N.Z., 10s.

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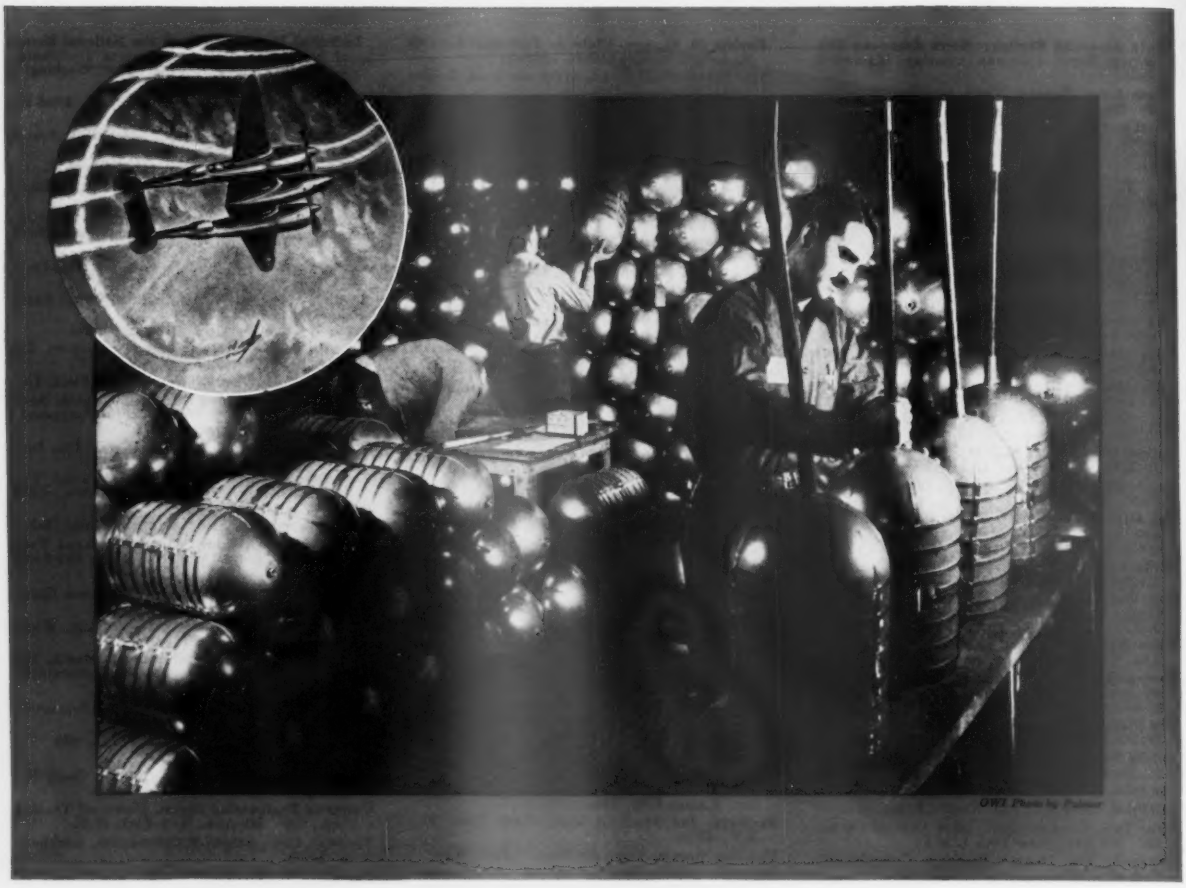

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The Zero Johnny Didn't Get. Attention is called to some errors of omission and commission in fighter-pilot tactics. Several incidents are considered in which enemy planes were not shot down when they should have been or in which fighter pilots faced trouble that could have been avoided. Overeagerness, excitement, lack of judgment, and unawareness are the basic causes of most of the situations reviewed. *Air Force*, May, 1944.

Informational Bulletin No. 3: Desert Operations. A 6-page illustrated booklet contains condensed advice for pilots concerning the special conditions to be expected during flight operations in desert sections. Precautions to be taken prior to flight, in taxiing, in the take-off, and during flight are outlined, with added remarks regarding combat tactics, desert navigation, and the return to base.

Informational Bulletin No. 12: Aircraft Operations in the Arctic. Special instructions to assist pilots in overcoming the conditions prevailing in arctic areas are contained in a 12-page bulletin. It outlines the precautions to be taken during preflight, taxiing, take-off, and flight. Detailed information is given about icing with regard to its occurrence and indications and the precautions and remedies to be applied with respect to the carburetor, wings and tail, propeller, pitot tube, and windshield. Advice is given on how to handle an iced airplane and how to land. Navigation and the effects of phenomena peculiar to the arctic regions are also discussed. *Training Aids Division, Office of the Assistant Chief of Air Staff.*

'Flying Submarine.' Major Arthur Gordon. An article on the unit of Flying Fortresses which makes reconnaissance flights over the Atlantic Ocean to gather meteorologic data for Allied air attacks in Western Europe. The type of low-level flying that must be done is described, and details are given on the equipment, crews, and activities. A routine mission is outlined from the briefing period until the bomber's return to a base in England. *Air Force*, May, 1944.

Arctic and Tropic Maintenance of Aircraft. A manual of 60 pages, prepared by the Arctic, Desert, and Tropic Information Center, Office of the Assistant Chief of Air Staff, Intelligence, is divided into two parts, Arctic Maintenance and Tropic Maintenance. It is intended to familiarize the personnel with general conditions and problems of maintenance on the line in nontemperate areas and to tell the men what to do under such conditions. It gives a general picture of the special problems arising in the presence of excessive heat or cold, the injurious action of dust and moisture, and other natural forces that make their work difficult. It provides the information to help in overcoming the handicaps to be encountered.

The Arctic section contains such general headings as: modification and winterization, personal comfort, general maintenance, routine check, preflight and daily maintenance, oil-dilution system, immersion heaters, external heat, emergency procedures, coolant, and lay-over instructions. Appropriate instructions are given for the proper care of all components of the airplane and its equipment, and how to perform the necessary duties under conditions prevailing in arctic climates.

In a similar manner, advice is given for correct procedures in maintenance and operations in wet tropics and in the desert, with attention to health and personal comfort as well as the preservation and satisfactory use of the equipment. Special precautions to combat the effects of corrosion, dust, and other conditions peculiar to the tropics are emphasized. *Air Forces Manual No. 10. Training Aids Division, Office of the Assistant Chief of Air Staff*, New York.

Matériel Command's "Index" of AAF Plane Parts. The *Index of Aeronautical Equipment*, recently completed by the A.A.F. Matériel Command, is now in use at war plants, procurement offices, supply depots, and flying fields—wherever American aeronautical equipment is made or used. It provides comprehensive, concise information on virtually every item of equipment used in A.A.F. planes. Its preparation was undertaken to provide an accurate reference to hasten procurement and delivery of material to the fighting fronts. The task of compiling, coordinating, editing, and checking the mass of information was enormous, for thousands of items are listed and many carry specification numbers varying with each manufacturer. Some parts are listed under as many as six different names.

The Index comprises six volumes, which more than meet the objective of providing standardized information and pointing out installational and functional interchangeability. With separate volumes for Armament, Pumps and Superchargers, Landing Gear, Electrical Equipment, Instruments, Oxygen, and miscellaneous equipment, all items are completely described. Illustrations aid in the identification. Additional information includes the production status of the item, its weight, dimensions, technical order number, stock number, specification number, A.A.F. drawing number, whether it is shipped complete or in subassemblies, its appearance and operation, the names of the manufacturer and his part number, and whether the Navy or the British also use the particular item.

First distributed to key Matériel Command personnel, every branch of the A.A.F. now uses the Index. The Navy has distributed thousands of copies to its stores and depots, and the R.A.F. Air Council has designated the Index an official R.A.F. publication. It has been sent to all overseas commands and throughout the United Kingdom and British dominions. Although the information contained in the Index is restricted, copies are available to approved individuals and corporations. *Production Engineering Section, Production Division, A.A.F. Matériel Command*, Wright Field, O.

Civil Aeronautics Administration

The Establishment of a Restricted Area for Seaplane Operation. F. H. Grieme. This report covers the historical background and consequent action taken in the establishment of a restricted area for seaplane operations in San Francisco Bay necessary for the protection of seaplanes and surface watercraft maneuvering in navigable water. It was prepared to provide a means for a better understanding of the problem involved and to offer guidance in future cases where the establishment of restricted areas for seaplane operations becomes necessary.

Realizing the impossibility of an early adoption of revised International Rules of the Road, the Federal agencies represented at various conferences agreed that in order to provide immediate protection for seaplanes and watercraft operating on the water's surface specially designated areas be provided for seaplane operations. A condensed record of a public hearing before the United States Corps of Engineers, copies

of the resultant order from the Secretary of War and United States War Department regulations, and other pertinent data, are included in the appendixes.

The action taken by the Secretary of War in this matter establishes a precedent, since the designation of the specified area in General Anchorage No. 6 in San Francisco Bay as a seaplane operating area is the first of its kind in the United States. *Technical Development Note No. 32*, January, 1944.

Aircraft Corrosion Resulting from the Use of Calcium Chloride on Airport Runways. C. J. Janes. Calcium chloride when mixed with sand or cinders and applied to icy airport runways has been found effective in providing a skidproof surface. This material is also used as a dust palliative. There is, however, considerable concern as to the possibility of serious corrosion resulting from continued splashing of calcium chloride on the structural components of the airplanes.

Information involving actual operation of aircraft on runways conditioned with calcium chloride was meager and inconclusive. The laboratory tests indicated that Alclad aluminum-alloy sheet was highly resistant to corrosion. Serious intercrystalline corrosion and embrittlement of the unprotected aluminum-alloy sheet, however, were noted. The tests also indicated that when alloy steel was subjected to corrosion while stressed its fatigue limit could be reduced to one-third of its normal value. The effectiveness of corrosion inhibitors has not been conclusively established.

A careful review of all available information indicates that considerable quantities of calcium chloride can be thrown up into the wing, as well as on the outside of the airplane, and that it will be deposited on portions of the aircraft constructed of unprotected aluminum-alloy and steel components. It can be driven into seams and crevices, and highly concentrated solutions can result from the evaporation of the water. Washing down of the airplanes will not completely remove this material from the seams or from the interior of the wings. Serious corrosion and embrittlement of the aircraft structures resulting from the use of calcium chloride on airport runways therefore appear possible. However, tests that closely simulate the conditions actually encountered in practice, as well as field surveys, must be conducted if a satisfactory solution of this problem is to be obtained. *Technical Development Note No. 33*, March, 1944.

Construction of a Goniometer for Use in Determining the Candlepower Characteristics of Beacons. F. C. Breckenridge and T. H. Projector. This report describes the construction and testing of a goniometer of sufficient capacity to mount a C.A.A. 36-in. double-end beacon or a 60-in. reflector. This goniometer was designed to rotate this equipment through horizontal and vertical angles and to set and hold these angles to an accuracy of $\pm 0.01°$ about either axis. The goniometer was built on the frame and mounting of an obsolete 60-in. coast-defense searchlight. *Technical Development Report No. 39*, February, 1944.

Index to Current Memoranda. A revised list of memoranda shows all Safety Regulation releases previously issued which are still in effect. It includes releases published in the period from May 31, 1940, to April 1, 1944, giving the release number, title, and date of publication. These releases are sent to different lists, according to the character of the subject matter. The lists are as follows: accessories manufacturers; engine and propeller manufacturers; scheduled air carriers; air-carrier officials; engineers, consultants, etc.; and repair stations. Copies of the index are sent periodically to all lists for checking purposes. *Safety Regulation Release No. 161*, April, 1944.

Weight Control of Air Carrier Type Aircraft. The purpose of this release is to promulgate weight-control procedures that are consistent with good loading and maintenance practices. It is not intended that the information contained herein will materially affect existing approved weight-control systems but rather to clarify certain procedures that were set up in Release No. 121 and also to suggest that all air-carrier operators operate under approved weight-control systems.

It is indicated that many air carriers are now operating under an approved system of weight control and that it is desirable for all to take steps to obtain approval of their weight-control systems by January 1, 1945, so that uniformity of handling may be effected and the necessity for individual supervision eliminated. Detailed instructions are given under appropriate headings for the establishment of weight-control procedures and for the preparation of the necessary reports, forms, and schedules. *Safety Regulation Release No. 162*, April, 1944.

A Study of the Sleep Motility of Student Pilots. Frank A. Geldard. As one step in investigating the emotional aspects of flight, a study of movements during sleep was undertaken. In order to investigate this sleep behavior a specially constructed instrument (the Simmons Kinetograph, slightly modified) was attached to the beds of a class of 12 student pilots undergoing C.P.T. training at the University of Virginia. This instrument records on a graphic recorder all of the major (trunk) and minor (head and limb) movements of the student while he is asleep.

In general, the results of the study were negative. After analyzing the records of these students (a) under normal living conditions before beginning their flight training; (b) following days on which flight lessons were given; and (c) following days during the training on which no flying was done, few significant changes were noticed in the sleep motility. This general conclusion seems to hold whether the amount of time spent in movement during sleep or the magnitudes of the movements are considered.

It is pointed out, however, that some of the students did change significantly in their sleep behavior. If a large group of subjects were studied, changes might occur in sleep motility frequently enough to be of value in the selection of pilots.

Unfortunately, the present study does not show whether those students who did change significantly in their sleep behavior were the ones who were good or bad in flying or who passed or failed the flight course. Until it can be shown that changes in sleep motility are characteristic of good or bad pilots or passing or failing students, the chief value of the present study is to point the way to further experimentation along these same lines. *Division of Research Report No. 28*, April, 1944.

Plan to Aid Civil Plane Design. The Civil Aeronautics Administration has proposed a new system of design requirements which would permit manufacturers to design aircraft according to their intended use. This would involve different categories of design with varying requirements for strength and performance according to the kind of work to be done. It is noted that the family airplane will not be required to meet the same stresses as a plane that will be subjected to acrobatics, and the weight thus saved can be put into additional fuel, baggage, passenger capacity, instruments, or other features.

Design categories that have been suggested for discussion by the industry are acrobatic, training, general purpose, transport, and special purpose. At the present time, special requirements for transport planes are in effect, but all other classes of civil aircraft must be built to the same strength requirements. Under the plan, manufacturers would need to incorporate only those design features essential for the intended use and could increase the overall efficiency of the design for that particular use.

It would still be possible to have a plane certificated by the C.A.A. in more than one category. For example, an airplane meeting the training category requirements at a weight of 1,500 lbs. could be used in general-purpose operations carrying a higher weight or in the acrobatic category at a reduced weight.

The top strength class would be for acrobatic planes, with requirements emphasizing power plants satisfactory for at least short periods of inverted flight and visibility for acrobatic flight. Training planes would be in a second strength class to cover maneuvers essential to primary training, such as spins, chandelles, wing-overs, etc., but not abrupt acrobatics such as snap rolls.

In the general-purpose category, the Administration envisions that requirements will emphasize good controllability at the stall, with strength features the same as in the transport category, since both types of operation avoid maneuvers that impose sharp stresses.

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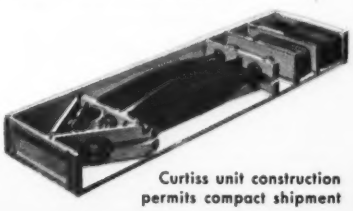

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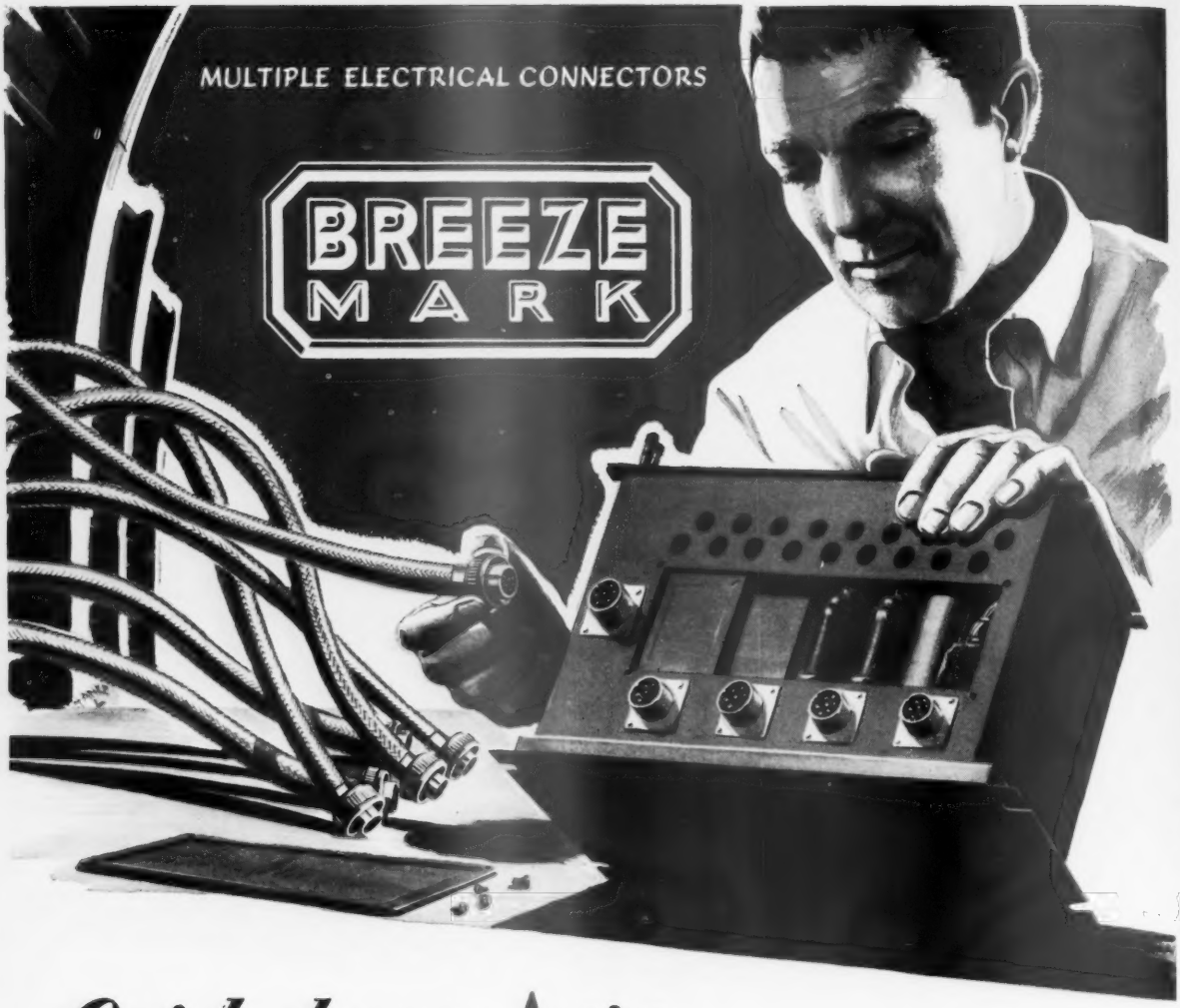

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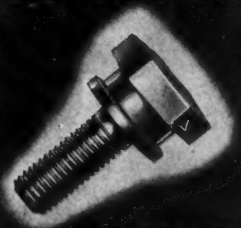

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Airplanes in the special-purpose category will be considered as separate cases.

Determination of Means to Safeguard Aircraft from Powerplant Fires in Flight. Part II. George L. Pigman. The problem of providing adequate fire protection in flight for modern, tightly cowled, air-cooled radial aircraft power-plant installations was previously discussed in *Technical Development Report No. 33*, "Determination of Means to Safeguard Aircraft from Powerplant Fires in Flight, Part I," for the conventional type cowling arrangement represented by the DC-3 airplane (AERONAUTICAL ENGINEERING REVIEW, January, 1944, page 111). It has been extended to another general type of cowling represented by the Curtiss-Wright CW-20 airplane. A full-scale, operating engine nacelle setup, similar in general arrangement but not in size or detailed construction to the Curtiss-Wright CW-20 airplane, was constructed and placed in a controlled air blast from a wind tunnel to simulate actual flight conditions. Various quantities of gasoline and oil were ignited at locations throughout the power-plant installation where fire might occur as a result of failure of the engine or of the fuel or oil systems. As in the tests of the DC-3 type installation, the procedure consisted of four phases of investigation: (1) fire extinguishment, (2) sources of ignition, (3) fire detection, and (4) effect of fire on materials.

In the fire extinguishment tests, a variety of different types of extinguisher-nozzle arrangements were investigated, and the effect of different quantities and rates of application of various extinguishing agents was determined. In addition, information was obtained concerning the effect of different operating conditions during fire extinguishment. With regard to sources of ignition, the possibility of ignition from the exhaust system, from electric sparks, or from the collection of explosive vapors was investigated for this type cowling. Tests were made of improved fire detectors and the optimum locations for installations of the various types were determined. Temperature readings were obtained throughout the nacelle, and observations were made of the effect of the fire on different structural materials at various locations. The effect of fire on the rubber tire, the oil and gasoline systems, the engine mount, the oil tank and oil cooler, and other miscellaneous accessories was determined. A comparison also is given between the DC-3 type cowling tested previously and the CW-20 type cowling with regard to the various aspects of the fire-protection problem.

In general, it was found that adequate fire detection and extinguishment could be obtained for installations of the CW-20 type and that the rates and quantities of extinguishing agent necessary were approximately the same as for the DC-3 type. It was also found that the absence of a diaphragm between the power and the accessory regions resulted in higher temperatures in the accessory region. *Technical Development Report No. 37*, October, 1943.

Determination of Means to Safeguard Aircraft from Powerplant Fires in Flight. Part III. H. L. Hansberry. A full-scale, operating Waco YKS-37 engine-fuselage-wing combination was fire-tested in a controlled air blast to simulate actual flight conditions. Quantities of gasoline and oil were ignited at locations throughout the power-plant installation where fire might occur as a result of failures of the engine or the fuel or oil systems. Four separate investigations were conducted concerning (1) fire extinguishment, (2) fire detection, (3) effect of fire on materials, and (4) sources of ignition.

Fire extinguishment systems of reasonable size and weight proved capable of extinguishing fuel and oil fires within limitations of fire size and duration under simulated flight conditions. These tests resulted in determinations of optimum agent-distribution systems, minimum agent quantities, and minimum agent-application rates necessary for protection of the engine installation tested. The fire-detection tests proved that quick, positive fire detection is practical and that wire-type fire detectors are considerably superior to unit detectors in installations of this type.

Tests on materials included the development of methods for making fabric and doped aircraft covering more resistant to flame and investigations into the use of nonmetallic firewalls. During oil and gasoline fires of various sizes and in various locations, temperatures of cowling, wing and fuselage skin, and the fire wall were recorded. The general effect of fire on the entire power-plant installation was observed throughout the tests. Ignition tests were conducted to determine the possibility of spontaneous ignition of gasoline, lubricating oil, and Diesel fuel oil. The tests showed that ignition sparks, the carburetor air-heating system, and cracks or openings in the exhaust system can be ignition sources. *Technical Development Report No. 38*, April, 1944.

National Advisory Committee for Aeronautics

Investigations of Single-Stage Axial Fans. R. Ruden. Translation of "Untersuchungen ueber einstufige Axialgeblaese," *Luftfahrtforschung*, July 20, 1937, and September 20, 1937. The investigations were connected with experiments on fans carried out by the writer in the Goettingen Aerodynamic Laboratory as a part of the preliminary experiments for the Goettingen wind-tunnel project. A fan rotor was developed which had high efficiency at the design point corresponding to moderate pressure rise and which, in addition, could operate at a proportionately high pressure rise. To establish the determining operating factors the writer carried out extensive theoretical investigations in Hanover. In this it was necessary to depart from the usual assumption of vanishing radial velocities. The calculations were substantially lightened by the introduction of diagrams. The first part of the report describes the theoretical investigations; the second, the experiments carried out at Goettingen.

It is customary, in the theoretical treatment of axial turbines, to set all radial velocity components equal to zero. It is found that this assumption makes it impossible to estimate the behavior of the fan over its entire operating range. In particular, no sufficient explanation can be given, on this assumption, for the fact that fan rotors with outwardly increasing blade chord maintain considerably greater throttling than rotors with outwardly decreasing blade chord. For the solution of the problem just outlined, formulas for the calculation of stationary and rotating cascades are derived which are based on a consideration of small radial velocities. The method of calculation differs from the hitherto customary one primarily in that, after the calculation of the individual cascade section characteristics, a through-flow distribution calculation must be undertaken which correlates definite operating conditions of the individual cascade sections. The usual cascade corrections are to be applied in the calculation of the section characteristics.

In the report the Betz method, which in the calculation of cascade corrections takes account only of the circulation of the neighboring profiles, is extended by the introduction of a thickness correction. In the determination of the cascade section characteristics, diagrams are introduced which substantially lighten the task of calculation. These diagrams give, in addition, a good survey of the existing possibilities and permit quick estimates to be made, as illustrated by a series of examples. The through-flow distribution calculation requires the solution of a differential equation, which is reduced to a simple iteration process on the corresponding difference equation.

The through-flow condition allows, for instance, the design of a rotor to change a nonuniform to a uniform energy distribution. Likewise, a simple method can be given for the determination of the blade chord distribution which guarantees constant energy over the whole through-flow cross section not only for the design operating point but over a wider throttling range. Finally, the through-flow condition permits a reliable estimate of the stability of the rotor flow to be made.

The comparison of the theoretical calculations for three rotors with the experiments shows that the torque on the rotor shaft can be calculated with greatest certainty. The efficiency can also be predicted with sufficient accuracy if the experimentally determined clearance losses are included. Greater uncertainties arise in the calculation of the efficiency of the total blower installation, including exit guide vanes and hub diffuser. In this connection the main difficulty may be ascribed to the rather little-known ac-

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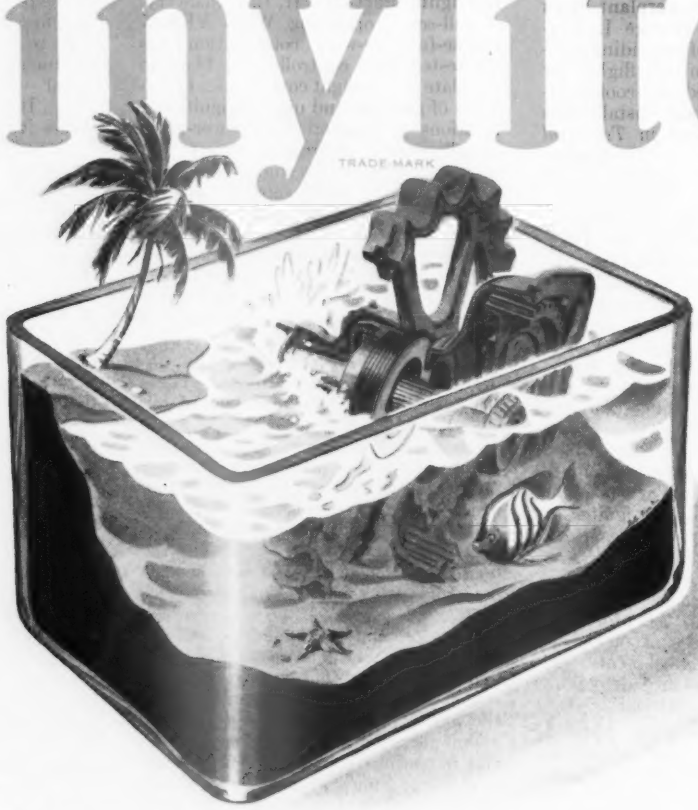

IT'S LITTLE THINGS LIKE GLUE LINES

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"On arrival at one of the Solomon Islands, we found an abandoned 'cat.' With jammed transmission, it had been dumped into the ocean 3 weeks earlier, thought impossible to repair . . . The Seabees fished it out . . . repaired transmission . . . in such a hurry they didn't even open the final drive . . . Working it 24 hours a day for 2 weeks, they established a base in enemy territory . . . 8 months later the machine was still in service, working hard." (From report of a Chief Petty Officer of the U. S. Navy).

A thin line of adhesive based on VINYLITE resin contributed in no small way to this remarkable service record. This adhesive is used to seal a cork gasket to the copper bellows of the final-drive sprocket shown in the cutaway view. This seal protects the precision mechanism that drives the endless tracks . . . through mud, muck, and sand. The outstanding tenacity and durability of the VINYLITE resin adhesive have been amply demonstrated on all the world-wide fronts where Caterpillar tractors are making history.

An adhesive that will withstand these severe tests on the war's exacting proving grounds will solve some manufacturers' postwar problems—whether it be a bond for metal, stone, cloth, paper, wood or plastics. Our Development Laboratories will be glad to help you adapt VINYLITE resin adhesive to your specific needs. Write Department 12 for literature.

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Plastics

tion of the hub diffuser. But for guide vanes there is an additional loss due to secondary flows which cannot yet be included with sufficient accuracy. The secondary flows of the boundary layers at the outside sections in rotors are practically nonexistent but do exist at the hub and in a manner equivalent in action to a boundary-layer suction. These facts explain why the maximum lift coefficient of the hub sections may be safely exceeded. Separation of the entire rotor flow sets in only when the maximum lift coefficient at the outer sections is exceeded.

On this basis, rotors with outwardly increasing blade chords are suitable for high loadings, especially since the through-flow distribution calculations show that the axial through-flow velocity in the neighborhood of the outer wall is considerably larger than the average through-flow velocity. For small flows more favorable working conditions for the outer blade parts are automatically produced.

In conclusion, experimental investigations on four rotors with adjustable blades and also experimental investigations on the influence of tip clearance on efficiency and the maximum attainable throttling are given. It is to be noted that the method of calculation derived for blowers may be applied directly to axial pumps. The application of the method to the calculation of axial turbines should offer no difficulty. *N.A.C.A. T.M. No. 1062*, April, 1944.

State of Michigan

Michigan Airports is the title of a ring-bound book of 76 pages containing a report of the activities of the Michigan Board of Aeronautics. It includes discussions of plans for the establishment and operation of airports, development of air lines, distribution of airplanes, and recreational uses of aircraft, as well as maps of present and projected airports and lists of airports arranged alphabetically and by counties. *Michigan Board of Aeronautics.*

State of New York

New York at Work for Victory and the Future. The 1943 annual report of the Division of Commerce of the State of New York gives a comprehensive review of the work and accomplishments of that department of the state government. It is divided into two main parts: (1) war activities and (2) postwar activities. Included in the second part is a special section concerning aviation, in which a report is given about the survey made by the Division of Aviation and its postwar possibilities in New York State. Among the subjects considered was the development of airports and airways, the problems of the airplane manufacturing industry in the state, and the place of the privately owned airplane in the postwar period. *Division of Commerce, Executive Department.*

Australian News and Information Bureau

Aircraft Industry Expands as New Combat Craft Enter Production. The expansion of the Australian aircraft industry is noted in connection with the transition from the manufacture of training aircraft to the production of operational types in the Commonwealth. It is stated that at least two private manufacturing concerns have turned over more than 1,000 planes to the Royal Australian Air Force, and the division of the Federal Department of Aircraft Production, which is building Beaufort bombers, delivered its 500th plane several months ago. The Australian aircraft industry has been developed almost entirely during the period of the war and now employs 42,525 skilled Australian workers, recruited from farms, shops, and offices. Both British and American types of aircraft are being manufactured, including, in addition to the Beaufort medium bomber, the Australian-designed Boomerang interceptor fighter. Most of the originals of the machine tools, hand tools, and gauges used were obtained from the United States. *Australia*, March, 1944.

British Information Services

Britain and the Common Pool. An illustrated booklet of 24 pages outlines the extent of the contributions of the British Empire to the combined effort of the United Nations in the war. It defines what is called the Common Pool and describes how the resources of the nations opposed to the Axis are being combined for the most efficient prosecution of the war. In a page referring to the air services it is stated that Britain is spending $472,000,000 in building airfields and depots for the United States forces. At the peak of the building program Britain was devoting two-thirds of all available personnel to the building of airfields, barracks, hospitals, roads, and other facilities for the American units. The building program alone is costing the British $600,000,000, and the joint Anglo-American air offensive is requiring a building program amounting to $2,460,000,000, of which Britain is paying $2,420,000,000 or 98.4 per cent. *British Information Services*, March, 1944.

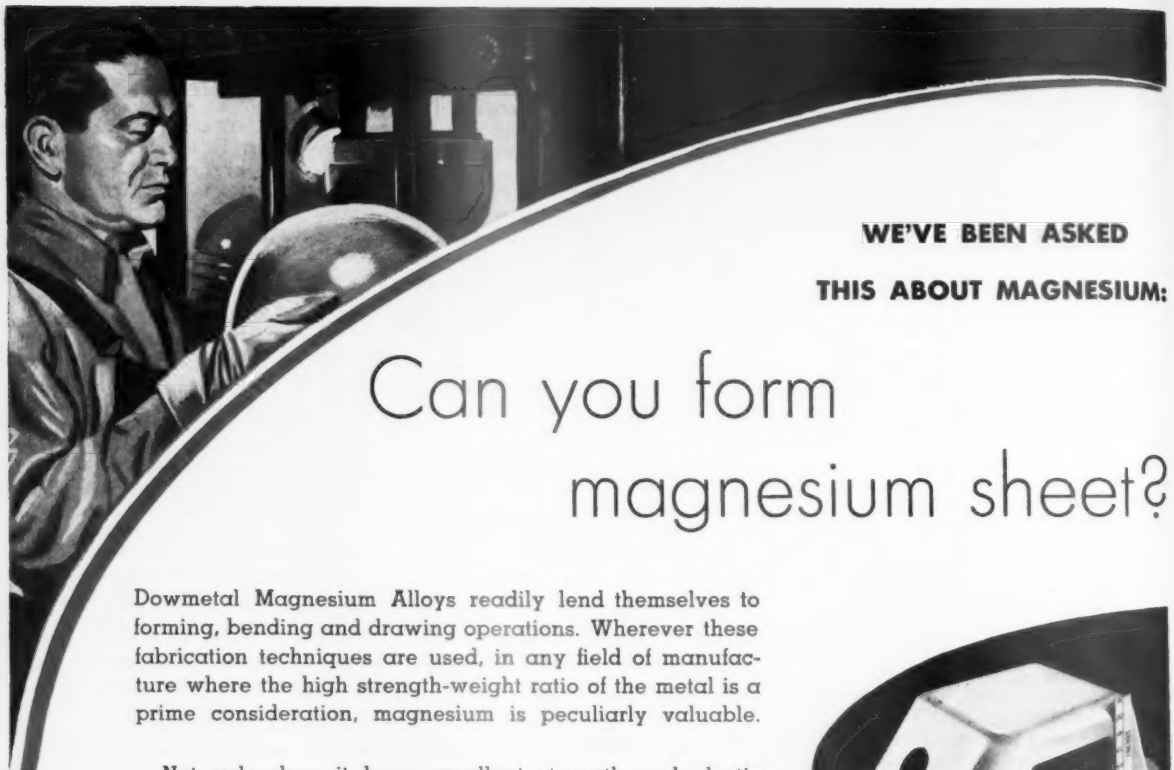
African Victory with the British Forces. A pamphlet contains articles that trace the operations of the British Forces in North Africa from El Alamein to the point where the enemy was driven off the continent at Cape Bon. Illustrations are numerous, including photographs of the troops in action and of important events. Aerial photographs are included, as well as drawings and diagrams. One article relates the achievements of the Royal Air Force, and others tell of the services performed by the navy, the tanks, and other branches of the services. Biographic sketches of the commanding officers are included.

On the Power Input Required to Maintain Forced Oscillations of an Aeroplane Wing in Flight. R. A. Frazer. It is shown that when steady oscillations of an aerodynamic system are excited at air speeds below the critical speed V_c for flutter the total work done per cycle by the exciting forces can be negative. When the air speed is close below V_c the work per cycle changes sign as the forcing frequency passes through resonance, and the sign below resonance depends on the conditions of forcing. These effects, which are attributable to the presence of unsymmetrical cross-stiffness, are illustrated in relation to the flexural-torsional oscillations of a cantilever wing. It is also proved that under certain conditions the total work done up to each instant of the cycle can be negative. In exceptional cases it is even possible for the time rate of the work to be negative throughout the cycle, and experiments with a simple model confirming this are described.

The sign of the work required to build up steady forced oscillations of an aerodynamic system that is initially at rest and in equilibrium is briefly discussed in the appendix. It is shown that the work done is certainly positive in the early stages of the motion.

The foregoing conclusions are of some interest in relation to von Schlippe's method for estimating critical speeds. The principle of this method is now well known. Forced oscillations of the wings or other relevant components of the airplane are excited at various air speeds below the critical speed by an out-of-balance oscillator, and at each air speed the frequency is varied to give maximum forced amplitude ("resonance"). Theoretically, a curve showing maximum amplitude plotted against air speed would have an asymptote at the critical speed, and the method proposed is to estimate the position of the asymptote by extrapolation. However, investigations in this connection have indicated that satisfactory results would not be possible in practice without dangerously close approach to flutter.

A modification of von Schlippe's method has been proposed in which the power input at resonance is measured instead of the forced amplitude. This suggestion is presumably based on the assumption that the power input provides a measure of the "damping." Since the effective damping is relatively small in still air and is actually zero at the critical speed V_c, the power input might perhaps be expected to reach its maximum at roughly $V_c/2$. If this were true, the critical speed could certainly be conveniently estimated without risk. However, the results given in the present paper make it clear that such a method would be unsound. With dissipative dynamic systems such as airplane wings, the power input required to maintain steady oscillations is, in fact, not related in any simple way to the damping. *Ministry of Aircraft Production, Aeronautical Research Committee, R. & M. No. 1872*, British Information Services, New York, $1.05.



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The Influence of Wing Flexural Axis Position and Aerodynamic Torsional Damping upon Wing Flutter. A. G. Pugsley and G. A. Naylor. While the inertia axis position of a modern monoplane wing is practically restricted to the 0.4*c* region, the flexural axis can, without undue difficulty, be varied in position from the usual 0.3*c* anywhere between 0.20*c* to 0.35*c*. To determine whether, from the stiffness standpoint, there is any best position for the flexural axis within this range, a series of flutter-speed calculations has been made using the simplified theory of *R. & M. No. 1839* with various estimates of the most uncertain parameter, the aerodynamic torsional damping.

With the usual rearward position of inertia axis the mass balancing of a wing by locating the flexural axis close to the inertia axis is not practicable, even if it were not also undesirable from a wing-divergence standpoint. With such practical restrictions it appears that the flutter speed of an ordinary wing is not sensitive to flexural axis position. The variation of the calculated flutter speed of a wing with change of torsional damping is greater when its flexural axis is behind the 0.3*c* position than when in front. The variation is also greater when the wing is light than when it is heavy. Thus, from the stiffness standpoint, there is at present some practical advantage in a flexural axis ahead of 0.3*c*. *Ministry of Aircraft Production, Aeronautical Research Committee, R. & M. No. 1879*, British Information Services, New York, $0.40.

Instructions for the Preparation of Weather Maps with Tables of the Specifications and Symbols. These instructions are based on the system of plotting observations on weather charts adopted by the International Meteorological Conference at Warsaw in September, 1935. They set out the approved method with regard to the entries normally made on working charts of observations from land stations and ships reporting in the New International Code (Copenhagen, 1929, Warsaw, 1935).

Section I deals with entries on working charts where the scale of the chart is large enough in relation to the network of reporting stations to permit details for each element to be entered on the single chart. These charts in the European area are normally on the scale $1:5 \times 10^6$ or $1:7.5 \times 10^6$. In areas where stations are wide apart, the charts may be on the scale $1:10^7$.

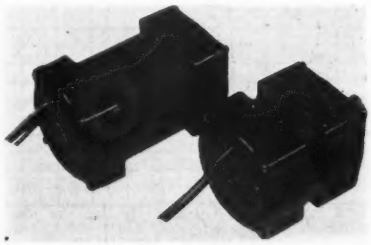
Section II deals with entries on charts where a part only of the information can be entered. These charts in the European area are usually on the scale $1:10^7$.

Appendix I gives a selection of International Symbolic Forms of messages with the meanings of the symbolic letters. Appendix II gives the complete specifications of the codes used for the individual elements appearing in the synoptic messages given in Appendix I, together with the corresponding symbols used in plotting. *British Air Ministry, Meteorological Office, Form 2459*, July, 1943. For sale by British Information Services, New York, $0.30.

(*Continued from page 23*)

Electrical Remote Positioning

For completely electrical remote positioning a simple bridge circuit may be used having a potentiometer in the cockpit which is the controller operated by the pilot. There is a potentiometer on the driven unit, and a polarized relay energizes the driven device whenever the controller is moved, keeping the driven device going until it is in a position corresponding to that of the controller, at which time the circuit is balanced. This system is subject to some variations. Experience indicates that it cannot be relied upon for accuracies closer than 2 per cent. Where the driven device must be positioned in smaller increments than 2 per cent of its total travel, it is felt that rather than make the relays more sensitive, the better solution is to replace the exceptionally sensitive relay by a rugged electronic vacuum tube. By this means a system has been developed which has an accuracy of repeatability of one part in 200 with positioning increments of one part in 5,000. In this system a Selsyn is used in the cockpit and on the power unit, with an electronic relay box located anywhere on the airplane. This electronic relay box is of a standardized size and shape. A number of them would be used on an airplane, and for quick installation they are mounted with a slide on each side with a quick connector on the end. As they weigh only about 3 lbs., spares can be carried and quickly slipped into place in the event of a failure. Since electronic tubes are lighter than any of the wired switching or relay devices otherwise considered, the electronic control seems to be the most promising for exact positioning. The reliability of vacuum tubes has been questioned, but in recent years they have been improved to the point where the entire navigation of the flight is dependent upon them. Such an electronic control is valuable for propeller controls, throttle controls, or any other type of control where accurate remote positioning is desired.



Typical Lear motors. The small motor weighs 3.5 lbs. and develops 1 hp.; the larger motor weighs 8.3 lbs. and develops 4 hp. Both motors are three-phase, four-pole, 400-cycle induction motors, using 195 volts at 12,000 r.p.m.

Temperature Modulating Controls

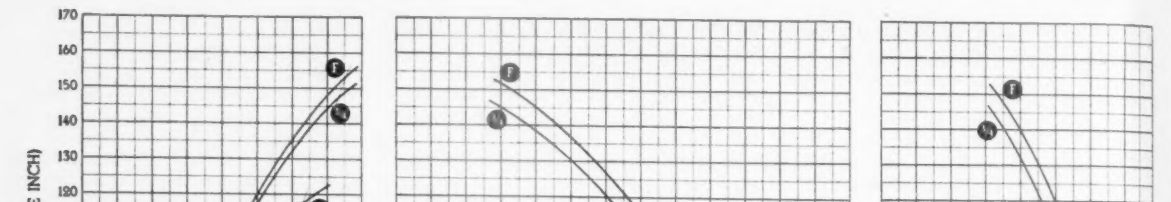
For automatically maintaining a desired temperature in various portions of the engine installation, such as cylinder temperature, glycol, oil, or intercooler air, automatic modulating controls have been developed and are in production. These have reached the stage where they have proved to be entirely reliable. They hold the temperature within practical limits under all conditions of flight within the possibilities of the range of the control device, such as the movement of the radiator shutter, cowl flap, etc. By the use of such devices it is possible to fly with the shutter opened no more than is absolutely necessary, eliminating any excessive air drag. Thus, with this automatic control, air speed is slightly increased, while the engine is usually operated within closer temperature limits than is usually practical with manual temperature controls.

Flexible Couplings

In the design of electrical-mechanical devices the use of flexible shafting has greatly extended the possibilities of such devices and simplified their installation. One might consider a gear mechanism having flexible couplings between portions of the mechanism and have the flexible coupling reach the proportions of a flexible shaft. By turning the flexible shaft at a fairly high speed, power can be transmitted at low torque in the condition analogous to the transmission of power at high voltage and low current. Originally, flexible shafting was used only for remote radio controls and, when power was applied to it, there was too great a variation in the shafting and the technique of applying the end fittings for reliability. However, by careful control of the shafting, the casing, and the fabrication of the end fittings, it has been possible to have flexible shafting that is practically trouble-free. Power losses in the flexible shafting are approximately the same as those in a simple, single-stage spur gear train. In one installation on a tricycle landing gear, each wheel has a separate power unit with all three wheels (including the nose wheel) connected to a single gear-box transmission with the length of the flexible shafting to the main wheel actuator being 320 in. on each side. On this same airplane, the wing flaps are also operated through a flexible shafting system having the flexible shaft over 300 in. long on each side of the fuselage.

What the Design Engineer Should Know

ABOUT HIGH TENSILE STAINLESS


STRESS "f"
(THOUSANDS OF POUNDS PER SQUARE INCH)
STRAIN "e"
(THOUSANDTHS OF AN INCH PER INCH)
TANGENT MODULUS "Et"
(MILLIONS OF POUNDS PER SQUARE INCH)
SECANT MODULUS "Es"
(MILLIONS OF POUNDS PER SQUARE INCH)

These curves show the tensile properties of ARMCO High Tensile Stainless Steel Sheets from tests made on longitudinal specimens as cold rolled. They are reproduced from a practical new handbook that contains compression and tension values of high strength stainless for the complete useful range.

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		¼ Hard	½ Hard	¾ Hard	Full Hard
Ultimate Strength—thousands of lb. per sq. in.	F_{tu}	133	162	183	187
Yield Strength at 0.2% Offset—thousands of lb. per sq. in.	F_{ty}	75	117	147	153
Proportional Limit at 0.01% Offset—thousands of lb. per sq. in.	F_{tp}	35	49	59	61
Initial Modulus of Elasticity—millions of lb. per sq. in.	E_o	27.0	27.5	28.0	28.0
Elongation—per cent in 2 in.		46	37	31	29

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BOOKS

Air Heraldry

Carl Mann

Contents: Wings and Badges, Military Aviator's Badge; Shoulder Patches and Insignia; Schools and Training Centers; Commands and Wings; Fighter Squadrons; Bombardment Squadrons; Observation Squadrons; Troop Carrier Squadrons; Air Base Squadrons; Service, Staff, Reconnaissance, Tow Target, Search Attack, Bombing and Gunnery, Transport, Photo, Ferrying, Communications, Weather Reconnaissance, Aviation, and Antisubmarine Squadrons; Group Insignia; World War I Aero Squadron Insignia; Color Index for World War I Squadrons.

Color has been added to the uniforms of American soldiers by the adoption of insignia in metal and cloth. Heraldic devices of many kinds are used to identify airplanes of squadrons and other units.

This book shows the design of hundreds of these insignia. Some are done by skilled artists, but others are almost sketchy cartoons. Courage and challenge are symbolized in many of the designs, but humor has a large place in the drawings. In no previous war has heraldry been so widely used to stimulate pride in branches of service. And none has gone so far in the field as the Army Air Forces. No book on an expanding topic such as this can ever completely cover the subject, but the compiler of this work has made an excellent showing of the art of aeronautical insignia as it is today.

The Institute is particularly pleased to have this book available for reference because in the Aeronautical Archives is probably the greatest collection of such insignia and cloth patches that may be found in any one place. *Air Heraldry* will assist in adding to the military section of its exhibit. Robert M. McBride and Company, New York, 1944; 255 pages, $3.50.

A Guide to Naval Aviation

Lt. Wallace W. Elton, Lt. Alfred H. Driscoll, Lt. Robert N. Burchmore, and Lt. Gray B. Larkum

Contents: Development of Naval Aviation; Aircraft Nomenclature and Glossary; Theory of Flight; Naval Aircraft; Lighter-Than-Air; Aircraft Maintenance; The Power Plant; The Aircraft Carrier; Bombs; Aircraft Guns and Cannon; Naval Air Organization; Naval Air Operations; Air Traffic Control; Aids to Air Navigation; Aerology.

With the exception of aeronautical annuals and books published outside the United States, books reviewed in this section may be borrowed without charge from The Paul Kollsman Library of the Institute of the Aeronautical Sciences, 1505 RCA Building West, 30 Rockefeller Plaza, New York 20, N. Y.

This is probably the most condensed presentation ever published about the background, organization, equipment, and operation of the U.S. Navy air force. The book was written as a result of the experience of the authors in teaching their courses at the Naval Air Station at Quonset Point, R.I. It is designed for the indoctrination of naval aviation officers.

Each topic is treated briefly and from the point of view of instructors who have to cover a wide field of information in the shortest possible time. When a student or any reader has read the book he has become acquainted with the essentials an airman must have for a background knowledge of naval aviation. McGraw-Hill Book Company, Inc., New York, 1944; 296 pages, $2.50.

Then There Was One

Eugene Burns

The first chapter of this book gives a disturbing account of pre-Pearl Harbor activities of the famous aircraft carrier "Enterprise" that made such a great record of success against the enemy after December 7, 1941.

On November 28 Adm. W. F. Halsey issued Battle Order No. 1, which stated that the "Enterprise" "is now operating under war conditions." This was followed by another, even more urgent. According to Navy Bureau instructions it was contrary to regulations to land planes loaded with bombs on a carrier. However, they favored that part of the order calling for the attacking and destroying of any ship that might endanger the task forces.

On December 2 the carrier was 174 miles north of Wake Island and sent twelve fighters to aid in the defense of that island. The "Big E" was due back at Pearl Harbor on December 6, but stormy weather fortunately delayed her arrival. At dawn of December 7 she was 150 miles from Hawaii. A scouting flight was launched to fly ahead to cover her arrival. When Admiral Halsey heard of the attack by the Japanese he ordered a search group to make contact with the enemy. They failed and he sent another search and attack group to try to locate the enemy ships. None was found. When the "Enterprise" finally entered the harbor and passed the wreckage and Hickham Field someone shouted, "Where in Hell were you?"

The carrier had been caught at this critical time low on fuel, but after filling her oil tanks she started to relieve Wake Island. However, when within one day's sailing distance, the news was received that the island had fallen, and the "Enterprise" was ordered to Midway. It is reported that the fighting Admiral swore for $1/2$ hour.

From then on there was almost continuous action. As the "Lexington," the "Yorktown," the "Hornet," and the "Wasp" were sunk and as other carriers were sent to other battle areas, it could be said for a time "Then There Was One."

The "Enterprise" and her Air Group received the Presidential Unit Citation for distinguished achievement in eight battles. Harcourt, Brace and Company, Inc., New York, 1944; 179 pages, $2.50.

Bataan: The Judgment Seat

Lt. Col. Allison Ind

As officers are being permitted to write of their experiences in many battle areas, new information that has been buried in official communiques becomes available to the public. Lieutenant Colonel Ind, while aide to Generals Henry B. Claggett and Harold H. George, had exceptional opportunities to observe the operations of the air force in the Philippines before war was declared and during the tragic days of disaster on Bataan Peninsula.

It will surprise many to learn of the intense, though ineffective, preparations for war which were made around Manila before the attack on Pearl Harbor. With so many Japanese spies sending information to their superiors, these preparations may have accelerated the decision to attack before the defense could be well organized. The request for more airplanes did not bring adequate reinforcements for obvious reasons. Differences of opinion as to the need for, and uses of, aircraft in warfare were evident. Brigadier General Claggett's health, age, and long Army service brought differences with the younger and more active air force

HIS LIFE DEPENDS ON FORMICA

Most American military pilots trust their lives, in some measure, to Formica, for vital control and communications parts on a very large percentage of the war planes in use are made of Formica.

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ARMY E NAVY

FORMICA

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officers, particularly with General George, who had advanced ideas as to the organization of aviation on the islands.

When Major Gen. Lewis H. Brereton took command of the Far Eastern Air Force in October, 1941, he speeded construction of new airfields and did what he could to put on a war footing the pursuit squadrons. Ninety first-line aircraft, 94 obsolescent types, and the 35 B-17's at Clark Field were all he had with which to defend Manila on December 7.

From then on the story is almost the author's diary of the attack of the Japanese and the retreat of the American Army, until the author was ordered to Australia with General Brereton and General George.

The book could be called a memorial to a great air force officer, Brig. Gen. Harold H. George, who lost his life shortly after his arrival in Australia. It gives the intimate details of his struggles to get reinforcements and his intense efforts to conduct a defense with so little. The Macmillan Company, New York, 1944; 389 pages, $3.50.

Blockade by Air

J. M. Spaight

Contents: Our Air Corsairs; Our Operations Against Shipping in 1941; Minelaying from the Air; The Mediterranean; Debit and Credit; The Place of Corsair-Work in the Air Offensive; The Gap of the North; A Scorched Sea Policy.

Although this book was written in 1942, the principles of air warfare as outlined have not been greatly affected by more recent events. As a background, there is given a history of such action from 1793 to the great successes in this war.

The cost of damage to shipping is compared with the results obtained. It was predicted that with the cooperation of the Royal Navy and the Royal Air Force the use of the sea would be denied to the Germans. This has now been accomplished. Furthermore, the author believes that the destruction of Japan's merchant fleet will be the main factor in her eventual defeat.

The conclusion reached is that England will always be dependent on sea power to protect the outer ring of the oceans. It will always be the master weapon. However, sea power cannot be effective without the cover of air power, so that in the future the airplane will play an even greater role in the protection of transport by sea. Geoffrey Bles, London, 1942; 153 pages, 10*s.* 6*d.*

The Enemies' Fighting Ships

Jay Launer

Contents: Japan, a Bombardier's Dream; Nomenclature of Naval Vessels; Japan, Principal Shipyards, Navy Yards, Aircraft Plants; Japan, Our Most Dangerous Naval Enemy; Nanyo, Japan's Amphibian Maginot Line; Japan's Naval Strategy and Her Battlefleet; Japan's Aircraft and Seaplane Carriers; Japan's Heavy Cruisers; Japan's Light Cruisers; Japan's Destroyers; Japan's U-Boats; Did Big Jap Subs Carry Baby Subs?; Japan's Minelayers and Minesweepers.

The Japanese Navy: Personnel, Insignia of Rank, Officer's Sleeves; Principal Naval Guns; Battleship and Battle Cruiser Data; Aircraft and Seaplane Carrier Data; Heavy Cruiser Data; Light Cruiser Data; Destroyer Data; Submarine Data; Naval War Losses; An Index of the Japanese Navy's Fighting Ships.

The German Navy: How Strong Is the German Surface Fleet?; Germany's Last Remaining Hope for Victory—The U-Boat; Personnel, Insignia of Rank, Officer's Sleeves; Principal Naval Guns; The Super Battleship *Tirpitz;* The Italian Battleship *Impero;* Battleship Data; Panzerschiffe Data; Aircraft Carrier Data; Heavy and Light Cruiser Data; Destroyer Data; Torpedo and Motor Torpedo Boat Data; Submarine Data; Fast Escorts Data; Motor Minesweeper Data; Naval War Losses; An Index of the German Navy's Fighting Ships.

The purpose of this book is to give as complete a picture of the fighting ships of Japan and Germany as is possible under wartime conditions. The emphasis is on capital surface vessels, omitting auxiliary and minor combatant vessels of little fighting value. Naturally, those interested in securing information regarding the naval air power of our enemies will seek the parts that have a bearing on this important phase of the war.

The author asserts that in 1943 Japan's aircraft production was not one-sixth of the United States output. At the most it was probably about 1,250 to 1,500 airplanes per month. It is stated that before Pearl Harbor Japan had nine first-line aircraft carriers to our seven. At the beginning of 1944 the ratio was nine to our 20. There is an excellent detailed description of the Japanese fleet of aircraft carriers, with hints that they may have built or may be building mystery carriers of exceptional power.

Germany, up to the end of 1943, had in commission only one aircraft carrier, the "Graf Zeppelin." It is unlike other carriers since it has two catapults for launching heavier bombers and torpedo planes.

It is the author's opinion that after the present war there will be only three major air powers—United States, Great Britain, and Russia—and that the Axis powers and their satellites will not be permitted to maintain military or naval air strength. Sheridan House, Inc., New York, 1944; 222 pages, $3.75.

The Oxy-Acetylene Hand Book

Contents: Part I, General Principles of the Oxy-Acetylene Process; Part II, Oxy-Acetylene Welding of Ferrous Alloys; Part III, Oxy-Acetylene Welding of Non-Ferrous Alloys; Part IV, Miscellaneous Applications; Part V, Oxy-Acetylene Cutting; Part VI, Inspection and Management; Part VII, Welding and Cutting Data; The Air-Acetylene Flame and Its Uses.

Basic oxyacetylene welding and cutting procedures are given in a handbook prepared for students and experienced welding operators. The manual may be used as a guide for self-instruction or as a classroom textbook in vocational, trade, and technical schools. It covers all the oxyacetylene processes and contains instructions for handling the common commercial materials, together with explanations of the various methods of depositing and controlling molten metal. Considerable space is given to an explanation of the operating principles of oxyacetylene equipment and instructions for its care and maintenance. The Linde Air Products Company, New York, 1943; 587 pages, $1.50.

Celestial Navigation

Walter Hadel

This is a problem manual on celestial navigation in which emphasis is placed primarily on the problem and secondarily on the theory of the subject. The reader is taken on imaginary navigation flights in which he determines the position of the aircraft by means of celestial fixes. The text contains many problems involving three-star fixes. Each problem illustrates a celestial navigation principle.

A complete solution is given for each type of problem, including information taken from the tools used, an explanation of how the tools were used, and the construction of the results on the accompanying charts. Each problem is followed by similar problems for the reader to solve. All tables, charts, and data required for the solution of the problems are included in the book. McGraw-Hill Book Company, Inc., New York, 1944; 284 pages, $3.25.

Aviation Mathematics

C. A. Felker, E. A. Schweinhagen, and H. W. Paine

Contents: Common Fractions; Decimal Fractions; Measuring Instruments; English and Metric Measurements; Applied Algebra and Formulas; Percentage and Its Applications; Square Root; Ratio and Proportion; The Slide Rule; Graphs in Aviation; Applied Geometry and Mensuration; Logarithms; Applied Trigonometry; Airplane Horsepower; Simple Mechanics and Aerodynamics; Essentials of Air Navigation.

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tained in this text. The book is intended to provide a sound mathematical foundation for more advanced studies. The instructional materials are arranged in the order of learning difficulty, and the teaching content progresses logically from the known to the unknown in each unit of each chapter. Following the explanations are practical problems to fix the mathematical principles learned, and written examples show the way in which the skills developed would have to be applied in actual aviation situations. The Bruce Publishing Company, Milwaukee, 1944; 356 pages, $2.72.

Airplane Engine Mechanics

Rolla Hubbard and Augustin Dilworth

Contents: CAA Regulations and Preparation for Licensing Engine Mechanics; Power Plants in General; Lubrication and Oiling Systems; Fuels, Induction and Fuel Systems, and Carburetion; Ignition and Electrical Systems; Engine Instruments; Engine Operation and Test; Cooling Systems; Propellers.

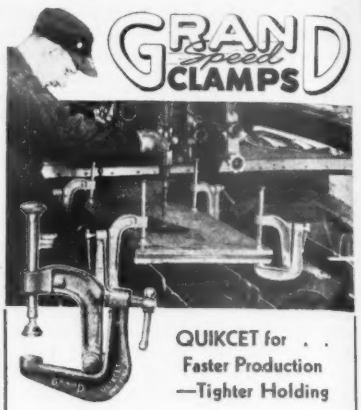
Prepared especially for aircraft mechanics, pilots, and machinists, this manual contains questions and answers designed to aid the student in preparing for Civil Aeronautics Administration examinations, particularly the examination for an airplane-engine mechanics license. The multiple-choice type of examination as used by the C.A.A. is followed, and the contents are closely allied to the type of instruction given by the Army Air Forces Technical Training Command. A detailed explanation of the procedure to be followed in applying for a C.A.A. license is included. McGraw-Hill Book Company, Inc., New York, 1944; 260 pages, $3.00.

Aircraft Mechanic's Pocket Manual

Joseph A. Ashkouti

Contents: Aircraft Identification Standards; Layout Methods; Shop Arithmetic; Flat Pattern Layout; Materials of Construction; Standard Aircraft Finishes; Standard AN Parts; Screw and Pipe Threads; Drilled and Reamed Holes; Tools; Nomenclature; Stress Fundamentals for Structural Repairs; Processes for Fabrication of Plastic Parts.

A loose-leaf manual prepared to give to the aircraft shopman the basic data he needs each day. The author has had access to the latest Army, Navy, and commercial aircraft-design recommendations, except, of course, confidential data not released for publication. The available data have been prepared to explain why the various methods, processes, and finishes are used in aircraft construction. Pitman Publishing Corporation, New York, 1944; $1.50.



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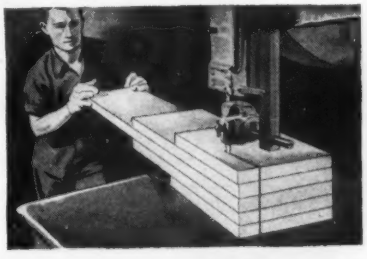

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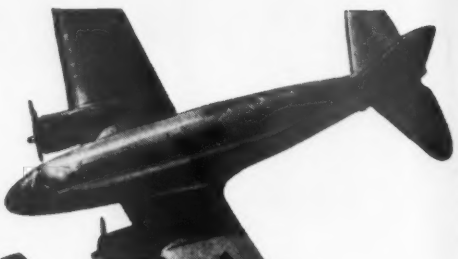

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John Q. Stewart and Newton L. Pierce

Contents: The Scope of Navigation; Position and Motion on the Earth; A Summary of Map Projections; Mercator, Lambert, and Gnomonic Charts; The Compass; Channel Piloting; Nautical Charts, Sailing Directions, or Coast Pilots, and Light Lists; Map Reading, Aeronautical Charts; Air Piloting; Coast Piloting; Tides and Tidal Currents; Dead Reckoning; Correction for Current and Wind; Relative Movement, Relative Motion at Sea; Relative Motion in the Air; The Sailings, Plane Trigonometry for Navigators; Radio Navigation; Introductory Outline of Celestial Navigation; The Navigators' Stars; The Marine Sextant and the Bubble Octant; Time and the Almanacs; Meridian Sights; Sumner Lines, Use of HO 214; Ageton's Method and Other Methods of Obtaining Sumner Lines; Steering by the Stars, Azimuths; The Day's Work at Sea, Procedures in Flight; Astronomy for Navigators; United States Government Agencies Which Aid Navigators; The History of Navigation; Tolerances; Drill Problems; List of Books; Excerpts from Tables; Charts in Color; Star Charts; Long-Term Almanac.

In this text marine and air navigation are treated as a unified subject. All phases of navigation which can be learned from a book or in the classroom are discussed. Sufficient explanations of the work and responsibilities of the navigator are given to sketch an intelligible picture for the inexperienced student. Numerous photographs and diagrams add clarity and interest. A special feature of the book is the large number of reproductions of charts and of Government publications essential for navigation. The characteristics and peculiarities of navigational charts are described. Problems of relative motion are clearly explained and celestial navigation is treated in a modern manner. A complete set of practical drill problems is provided. Ginn and Company, New York, 1944; 472 pages, $4.50.

Military Maps and Air Photographs

A. K. Lobeck and Wentworth J. Tellington

Written especially for the topographic draftsman, this book is designed as the basis for a course of instruction and as a reference. The authors' aim has been to combine under one cover the information necessary for an elementary course in topographic drawing and to include a revised and more elaborate use of symbolic drafting as it has recently been developed by the allied engineering industries.

The symbols and maps included are of about the size that the student should draw. Symbols are also shown as compiled into a map, emphasizing toning and pleasing appearance. Simple, concise directions for use in compiling various kinds of maps are provided. The use of water colors and colored pencils in compiling display maps is demonstrated and explained. An extensive set of topographic symbols is included. McGraw-Hill Book Company, Inc., New York, 1944; 256 pages, $3.50.

Book Notes

Tell the Folks Back Home, by James M. Mead; D. Appleton-Century Company, Inc., New York, 1944; 298 pages, $3.00.

Senator Mead of New York was sent by President Roosevelt with four other senators on a 45,000-mile tour of every American base and fighting front. This book gives his impressions of how the war is going and how the service men are faring. During the trip the Senator flew over many air routes, and he tells of the ferry and combat pilots he met. He tried to get the facts and the book shows he was successful.

Poles in Uniform, by Aleksander Zyw; Thomas Nelson and Sons, Ltd., London, 1943; 128 pages, 12*s.* 6*d.*

A Polish artist made sketches in a notebook of his impressions of life in the Polish army, navy, and air force serving in England. The large number of sketches of airplanes and pilots indicates the heavy role they are playing in the armed effort of the Poles to get revenge against their German enemies. As with all sketchbooks, the artist can say more with a few strokes of the drawing crayon than can be told in many pages of text.

Der Aufbau der Zweistofflegierungen (Crystalline Structure of Binary Alloys), by M. Hansen; Verlag von Julius Springer, Berlin, 1936. Photo reprint reproduction published and distributed by authority of the Alien Property Custodian by Edwards Brothers, Inc., Ann Arbor, Mich., 1943; 1,100 pages, $16.25.

The author has endeavored to compile uniformly the latest information on the behavior of two metals toward one another, as indicated by their solidification diagrams. This information is intended to bridge a gap that has been noticeable in metallurgical writings for a long time. The solidification diagrams of almost all binary alloys in their present form, especially of those which are technically important, are the result of a development that may be traced back for decades. This development is characterized by the collection of many quite extensive but partial results.

After the preparations that enabled the development of the first binary solidification diagram, it became necessary to have a general survey of the structure of the most important binary alloys (disregarding quantitative details), for that was an entirely unexplored field. These investigations revealed whether or not any of the alloys within the binary system would be of practical value. Based on the solidification diagrams the fact became clear that there are regular relations between the structure and the properties of the alloys. The need for a most exact knowledge of the solidification diagrams was felt, especially since results in other branches of metallurgy revealed how important these diagrams are for the production and development of metals. The solution of the problem was made possible by the steady improvement of research facilities, and the application of X-ray analysis has played a prominent part in the progress toward final realization.

Navy in the Sky, by Lt. Wallace W. Elton; McGraw-Hill Book Company, Inc., New York, 1944; 104 pages, $2.00.

This book, containing many carefully selected Navy photographs, was conceived to aid in the indoctrination of new naval aviation personnel. As a pictorial commentary with succinct text, it will interest civilians who wish to become better acquainted with the life of the naval airman and the broad activities of sea-borne aviation.

It takes the reader into the history of the Navy's participation in aeronautics through the combat work of the pilots of the Navy, including the Marine Corps.

Shore Leave, by Frederick Wakeman; Farrar & Rinehart, New York, 1944; 310 pages, $2.50.

There will be varying comment from readers regarding this novel. Written by a Navy man who was discharged for medical reasons, it describes the way three or four pilots spend their leaves in San Francisco, New York, and San Diego after duty in the Pacific area. The riotous parties and cynical points of view may give the impression that it is a general habit of naval airmen. Anyone believing that this is a typical picture of their life when not on active duty will be mistaken.

Wings over America, The Story of American Aviation, by Harry Bruno; Halcyon House, Garden City Publishing Company, New York, 1944; 333 pages, $1.49.

This book was published originally as *Wings Over America* and has been retitled for sale at a lower price. It gives interesting stories of people with whom the author has been associated in his long career in aviation. It is autobiographic and provides interesting material on many phases of American aviation.

A Proposed Method for the Computation of the 10,000-Foot Tendency Field, by E. H. Miller and W. L.

Thompson; The Institute of Meteorology of the University of Chicago, Miscellaneous Reports No. 1, The University of Chicago Press, Chicago, 1943; 20 pages, $0.25.

The authors of this paper discuss a proposed method for computing the pressure tendencies for the 10,000-ft. chart and show how these tendencies can be used in forecasting the movement and the deepening or filling of isobaric systems at that level. In conclusion the 10,000-ft. tendency field for a particular weather situation is computed. This series shows the feasibility of the proposed method and, at the same time, brings out some interesting facts concerning the use of the upper-level chart.

Understanding Aircraft Components by Question and Answer, by W. Hazell; The English Universities Press, Ltd., Bickley, Kent, England, 1943; 152 pages, 2*s.* 6*d.*

Operating principles and functions of various aircraft components and accessories are explained by the question-and-answer method. Text is divided into eight chapters. The first deals with engine and aircraft instruments; the second, with propellers; the third, with the Exactor Control; and the fourth, with oil, fuel, and coolant-system components. Chapter V is on the construction of pipe lines and the Avioflexus hose; Chapter VI, on the B.T.H. air-compressor, the Pesco vacuum pump, the "Bristol" fuel pump, and the Pesco gear and vane pumps; Chapter VII, on the K.L.G. Corundite sparking-plug; and Chapter VIII, on the Garviner fire extinguisher.

Airwomen's Work, by Leonard Taylor; Sir Isaac Pitman & Sons, Ltd., London, 1943; 54 pages, 1*s.* 6*d.*

A guide for airmen and airwomen containing information about life in the Royal Air Force. Subjects covered include ranks, regulations, rates of pay, promotion, and uniform.

Handbook of Commercial, Financial and Information Services, compiled by Walter Hausdorfer; Special Libraries Association, New York, 1944; 207 pages, $3.00.

The 1944 edition, more comprehensive than the 1931 and 1939 editions, contains 577 listings of current service organizations giving the name, address, and a brief description of the service rendered and rates charged by each of these information services. The information given comprises economic, statistical, and advisory data for commercial, financial, and other business operations, as well as for libraries. A section has been added in which are listed 311 services discontinued in recent years.

Rahmenformeln (Frame Formulas), by A. Kleinlogel; published and distributed in the public interest by authority of the Alien Property Custodian by Frederick Ungar Publishing Company, New York, 1943; 460 pages, $7.50.

This is a book containing ready-to-use formulas for determining the static loads for any conventional, single-panel structural form made of concrete, steel, or wood. There are 114 frame forms and 1,643 illustrations, presenting general and special load cases on bars.

The Theory of the Gyroscopic Compass and Its Deviations, by A. L. Rawlings; The Macmillan Company, New York, 1944; 182 pages, $3.00.

This second edition of a book on the theoretical fundamentals of the gyroscopic compass contains a considerable number of changes and additions. Among its revisions are the following: A simplified version of the section on differential equations is now included with the appendixes; the description of the Sperry compass has been extended to include some later developments; a new section deals with the compass manufactured by the Arma Corporation; the mathematical treatment of Brown's compass has been eliminated; and the appendix on the Phillpotts Report has also been omitted.

Materials and Processes, edited by James F. Young; John Wiley & Sons, Inc., New York, 1943; 628 pages, $5.00.

Materials and manufacturing processes employed by design engineers are described in a reference and textbook providing information useful in the selection of materials for design. The book is divided into two parts: one devoted to materials and their properties and the other to various manufacturing processes.

Elements of Mechanics, by Capt. Burr W. Leyson; E. P. Dutton & Company, Inc., New York, 1944; 176 pages, $2.50.

A simple explanation of what machines are and how they work. Ordinary and complex details of machines are described with the aid of photographs and sketches.

How to Understand and Use Flying Model Airplane Plans, by Paul K. Guillow; Paul K. Guillow, Wakefield, Mass., 1944.

Written especially for boys, this book contains plans and information regarding the design, building, and operation of model airplanes.

Mohune's Nine Lives, by Pelham Groom; Liveright Publishing Corporation, New York, 1943; 326 pages, $2.00.

A novel about espionage in which the central figure is a squadron leader on active duty with the R.A.F.

1,000 Questions and Answers for Aero-Engine Mechanics, by P. W. Blandford and H. C. B. Mackey; Hutchinson's Scientific & Technical Publications, London, 1943; 2*s.*

A book of questions and answers for apprentices and students who are learning to be aircraft mechanics and preparing for examinations. It is particularly intended for R.A.F. trainees and A.T.C. cadets.

Airplanes; E. M. Hale and Company, Milwaukee, 1938; 24 pages.

Information about air transport planes and how they are operated by the air lines is given in simple language. The book is intended for young people.

Fundamentals of Flight, by R. Abbott; J. M. Dent & Sons Ltd., London, 1942; 62 pages, 2*s.* 3*d.*

A primer on the principles of flight designed to meet the requirements of the student who does not have an extensive knowledge of mathematics. The four chapters of the text are concerned with: (1) the flow of air over differently shaped objects and streamlining; (2) airfoils and their characteristics; (3) stability and control of aircraft and the propeller; (4) maneuvers and performance. A glossary of terms is included.

Building an Airplane, by Paul K. Guillow; Paul K. Guillow, Wakefield, Mass., 1943.

With the aid of plans and sketches, this booklet tells how to build model airplanes.

A Study in Forecasting of Radiation Fog and Stratus at Omaha, by Gilley T. Stephens; The Institute of Meteorology of the University of Chicago, Miscellaneous Reports No. 11, The University of Chicago Press, Chicago, 1943; 27 pages, $0.75.

The purpose of this paper is to demonstrate certain considerations that may prove helpful in the preparation of a forecast for ceiling and visibility when these are likely to be limited by the formation of radiation stratus fog. To provide some indication of the relative importance of these considerations, examples from a study of radiation fog and stratus at Omaha, Neb., are given. Some comparisons are also made of low ceilings and poor visibilities associated with causes other than radiational cooling.

Electrical Trouble Shooting on the Motor Car, by Alfred Herbert Packer; A. H. Packer, Chicago, 1944; 559 pages, $4.00.

A 20-page section devoted to aircraft magnetos has been added to the latest edition of this book on the location of troubles in automobile electric systems. Information about magnetos for light airplane engines and for the large engines used for transport and military aircraft is included. The sections on voltage regulators should also be of value to aircraft mechanics.

Elementary Rivet Theory, by William R. Blommel, Lt. Benjamin W. Wheatley, and Edwin L. Johnson; D. Van Nostrand Company, Inc., New York, 1943; 57 pages, $1.00.

An elementary and easily understood course in riveting is presented in the form of a beginners' manual. Among the subjects included are safety rules, layout and drilling procedure, rivet computations riveting procedure, aluminum and its alloys, inspection and repairs, and special forms of riveting.

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A Simple Study of Flight, by J. D. Haddon; Sir Isaac Pitman & Sons, Ltd., London, 1943; 102 pages, 4*s.* 6*d.*

This is the third edition of a book on the theory of flight. Lift and drag coefficients that were adopted as British standards after the preparation of preceding editions are included; a new chapter has been added on "Airscrews"; and discussions of the "Townend ring," spin, and induced drag have been introduced. This book is one of the "Aeronautical Engineering Series."

Twentieth Century Engineering, by C. H. S. Tupholme; Philosophical Library, New York, 1944; 201 pages, $3.00.

A survey of some of the more outstanding engineering developments achieved during and immediately before World War II. The book is concerned with only those developments that have proved commercially successful. One chapter out of nine is devoted solely to the progress made in aeronautical engineering. In that chapter the main characteristics of modern aircraft and the nature of those technical developments that have made such characteristics possible are reviewed.

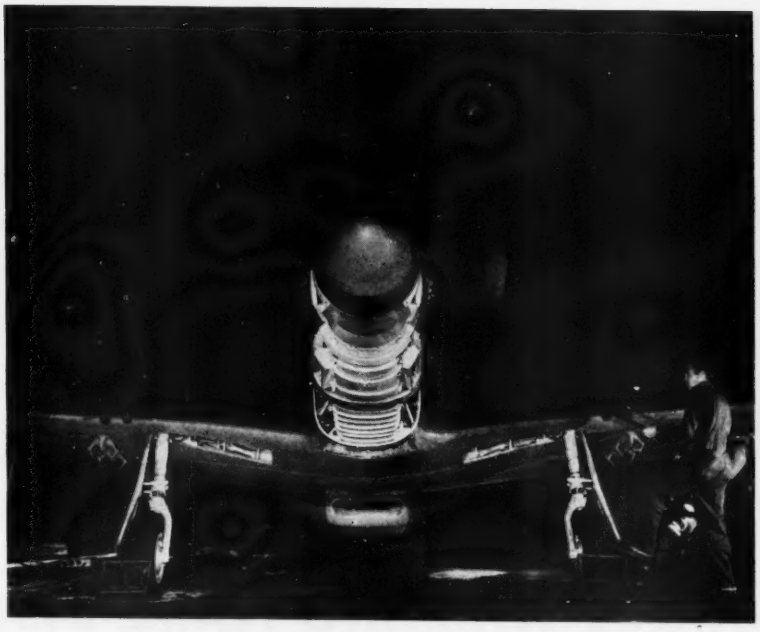
Foundations of Potential Theory, by Oliver Dimon Kellogg; The Frederick Ungar Publishing Company, New York, 1943; 384 pages, $6.00.

A systematic treatment of potential functions. The text has a twofold purpose: first, to serve as an introduction for students whose attainments in calculus include some knowledge of partial derivatives and multiple and line integrals; second, to provide the reader with the fundamentals of the subject preparatory to the applications. Beginning with the force of gravity, fields of force, the potential, and the divergence theorem, the study proceeds to properties of Newtonian potentials at points of free space, properties of Newtonian potentials at points occupied by masses, potentials as solutions of Laplace's Equation, electrostatics, and harmonic functions. It also deals with electric images and Green's Function, sequences of harmonic functions, fundamental existence theorems, and the logarithmic potential.

Superchargers for Aviation, by Sanford A. Moss; National Aeronautics Council, Inc., New York, 1944; 103 pages, $1.00.

Revisions in this second edition of a text about the development of the supercharger are minor ones and the contents closely follow those of the first edition. The chapter heads are self-explanatory: Developments Underlying the Supercharger; Arrangement and Use; Supercharger History; Details of Superchargers; Turbosuperchargers; Supercharging Theory; Cabin Superchargers; The Supercharger in War.

Aircraft Fitter's Handbook, by A. C. Robinson; George Newnes Ltd., London, 1943; 124 pages, 7*s.* 6*d.*



A North American P-51 Mustang fighter receives final engine run-up during night tests at the aircraft plant.

A book written to assist the aircraft fitter who is concerned with the fitting and assembly of the components that form the complete aircraft. In order that the fitter may have a proper appreciation of the importance of his work, the functions of the various aircraft components are explained.

Workshop processes are described. The heat-treatment of steel and Duralumin and the riveting of aluminum and its alloys are described in considerable detail. Included in the book are reference tables and a glossary.

Electrical and Radio Notes for Wireless Operators: Air Publication 1762; His Majesty's Stationery Office, London, 1940; 220 pages, 3*s.* 6*d.*

A handbook of information about the construction and operation of wireless communications equipment and the electrical phenomena involved. Chapter headings are as follows: The Electronic Structure of Matter; Cells and Batteries; The Effects of a Current; The Electric Motor and Measuring Instruments; Electro-magnetic Induction; Electrostatics; Alternating Currents; The Thermionic Valve; The Simple Transmitter; Detection: Amplification; Master Oscillator Controlled Transmitters; The Superheterodyne Receiver; Aerials—Direction Finding; Power Supplies for Radio Transmitters and Receivers.

Sweet's File, Mechanical Industries Reprint: Machine Tools and Other Production Equipment; F. W. Dodge Corporation, Sweet's Catalog Service, New York, 1943.

A new edition of Sweet's file of manufacturers' catalogues gives the usual compilation of machines, tools, and industrial equipment. Sections include the offerings of the Denison Engineering Company, Hydraulic Machinery, Inc., and the Taft-Peirce Manufacturing Company in the field of airplane equipment.

Meteorological Results of Cruise VII of the Carnegie, 1928–1929: Meteorology—I, by Woodrow C. Jacobs and Katherine B. Clarke; Carnegie Institution of Washington, Publication 544, Washington, D.C., 1943; 168 pages, $2.00.

The meteorologic data discussed in this book comprise the ordinary meteorologic observations taken on board the nonmagnetic ship "Carnegie" during its seventh cruise (1928–1929). The "Carnegie" had become well known to scientists throughout the world for its magnetic surveys of all oceans during six previous cruises from 1909 to 1921. Before embarking on the seventh cruise, however, the vessel was refitted and equipped for special oceanographic and meteorologic work, as well as for magnetic and atmospheric-electric observations.

The route followed encompassed a large part of the Atlantic and Pacific oceans, starting at Washington and going to Iceland and northern Europe, back through the Panama Canal, touching ports on the west coast of South America, exploring the eastern sections of the Pacific, then proceeding westward across the Pacific between latitudes 20° north and south of the Equator to Japan. Turning eastward, the cruise followed a route across the North Pacific, approaching the Aleutian Islands, and down to San Francisco, then to the Hawaiian Islands, circling the central Pacific, and going on to Samoa. There, while taking on gasoline, an explosion and fire destroyed the vessel and all its equipment. The

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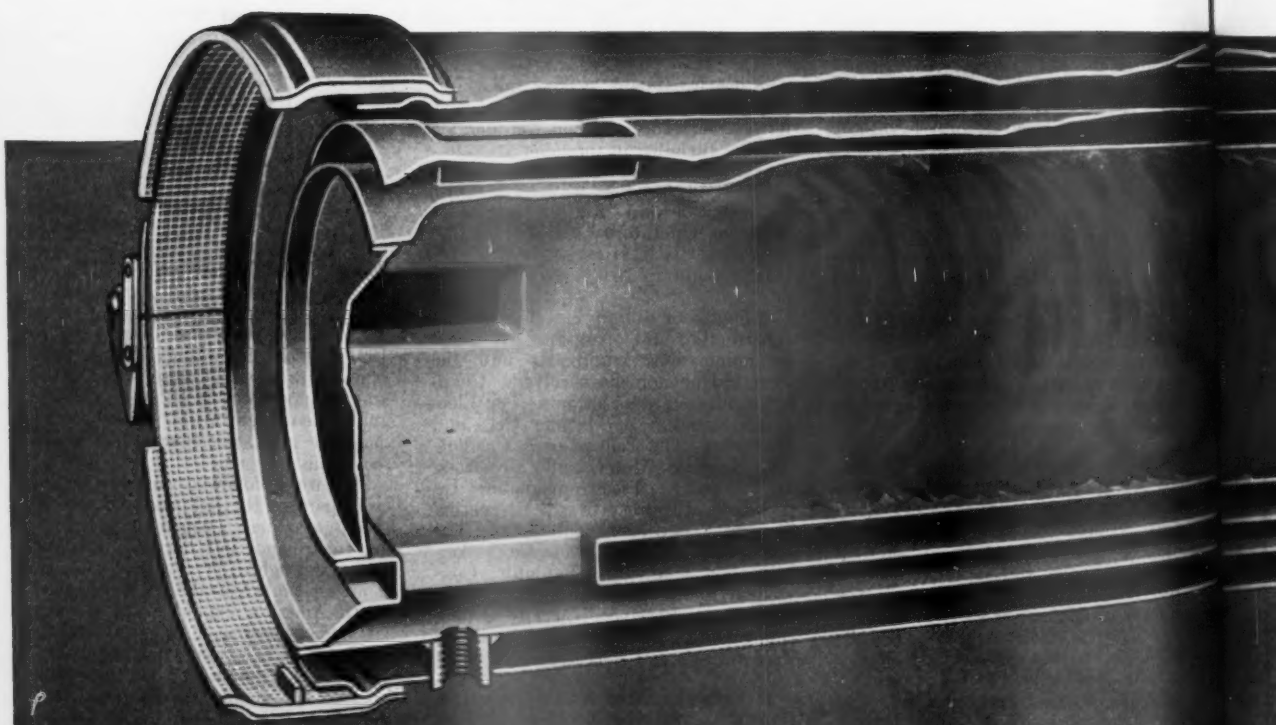

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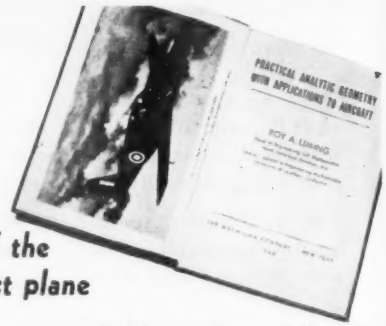

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cruise occupied 376 days and covered nearly 45,000 nautical miles of the planned 110,000-mile trip.

Complete meteorologic observations and records of sea-surface temperature and of the state of the sea were made each day at noon (GMT), the data being entered on forms supplied by the U.S. Weather Bureau. One copy of these forms was forwarded to the Weather Bureau and another was retained on the "Carnegie." The complete series of these noon observations is given in tabular form as Appendix II of this report (Table 76).

In addition to the observational work outlined, the meteorologic program of the "Carnegie" called for continuous recording of atmospheric pressure, sea-surface temperature, and wet- and dry-bulb temperatures on deck and at two levels above the deck; for periodic measurements of evaporation; and for the determination of upper-air winds by means of pilot balloons. Also, at each watch the ship's officer entered a record of prevailing and special weather conditions in the log; most unfortunately, the original logbook was destroyed with the ship. Abstracts of the log had been prepared and mailed to the Department of Terrestrial Magnetism, Washington, D.C., each time the "Carnegie" touched port. This abstract has been extremely useful in determining average weather conditions for certain days of the cruise and for locating positions. The abstract is included in this report as Appendix I. The data gathered are reported under the following headings: Atmospheric Pressure; Air Temperature; Sea-Surface Temperature; Humidity; Evaporation; Miscellaneous Meteorological Phenomena.

Upper-Wind Observations and Results Obtained on Cruise VII of the Carnegie: Meteorology—II, by Andrew Thomson; Carnegie Institution of Washington, Publication 547, Washington, D.C., 1943; 93 pages, $1.00.

This volume contains the results of pilot-balloon observations taken on the seventh cruise of the "Carnegie." The work was undertaken because the proposed route of the ship lay across rarely visited parts of the oceans where no upper-air data had been obtained. The value of such upper-wind observations in the navigation of flying craft over the ocean, as well as in the elucidation of problems of the atmospheric circulation over the earth's surface, was recognized. Since the study of upper-air currents was not within the geophysical program, the cooperation of Government organizations engaged in aerologic investigations was enlisted, including that of the Bureau of Aeronautics of the Navy, the Meteorological Service of the Signal Corps, and the Army Air Corps, as well as the Aerological Division of the Weather Bureau.

Observations were taken by means of a shipboard theodolite beginning October 27, 1928, in the Gulf of Panama, and throughout the cruise in the Pacific the officers took advantage each day of any opportunity when the skies were comparatively free from clouds. The only part of the cruise without observations was from July 3 to 21, 1929, in the northern Pacific about latitude 50° north, when fog, low clouds, and almost uninterrupted foul weather would have prevented the observer's following the balloons for more than 2 min. Only five of the 171 flights in the Pacific were made in higher latitudes than 40° north. Of 110 flights within the tropics, 29 were made north and 81 south of the Equator. Thus, the majority of the observations were inside the tradewind regions. Here a comparatively small number of observations reveals the typical air movements characteristic of the locality more clearly than an equal number of the observations made in temperate or polar regions.

The balloons were observed to the following heights: 171 balloons at the surface; 153 at 1 km.; 112 at 2 km.; 90 at 3 km.; 76 at 4 km.; 58 at 5 km.; 38 at 6 km.; 23 at 7 km.; 14 at 8 km.; 10 at 9 km.; 5 at 10 km.; 3 at 11 km.; 2 at 12 km.; and 1 at 12.5 km. The observers followed one-half the flights to 3.5 km. In the highest flight, No. 77, on the afternoon of March 18, 1929, an extreme height computed to be 12.8 km. was attained. The information obtained is reported under the following headings: Equipment Used in Upper-Wind Observations; Reduction of Observations; Procedure; Meteorological Conditions during Pilot-Balloon Flights, 1-171; General Circulation of Winds over the Tropical Regions of the Pacific; Height of Clouds Over the Pacific Ocean; Trade Winds.

Correlations of Isallobaric Patterns in the High Atmosphere with Those at the Surface, by Ernest G. Bice and Gilley T. Stephens; The University of Chicago Press, Chicago, 1944; 44 pages, $0.75.

A two-part study made by the authors while attending the Institute of Meteorology under scholarships granted by the U.S. Weather Bureau. The first part embodies the following: certain correlations between the 24-hour pressure changes at the 13-km. level and the 24-hour pressure changes at the surface on the following day; correlation of the 24-hour pressure changes at the 13-km. level and those at intermediate levels the same day and the following day; correlation of the 24-hour pressure changes at intermediate levels and those at the surface the next day; the apparent effect of the changes in pressure at 13 km. on the flow pattern at the 3-km. level for the following day; correlation of the 24-hour pressure changes at the surface and the 24-hour potential temperature changes at 13 km. the preceding day. The second part is a discussion of a situation that did not follow the rules dictated by the correlations set forth in Part I. In order to account for such cases of failure, an auxiliary chart making use of advective changes is used in conjunction with the high-level isallobaric maps for forecasting the regions of maximum pressure change at the ground.

Camouflage, Theory and Practice: A Summary, by Milton S. Fox; The Cleveland Museum of Art, Cleveland, 1943; 24 pages, $0.25.

The second in a series of "Art and War-Time" publications put out by the Cleveland Museum of Art is a booklet outlining the principles and techniques of camouflage. Explaining the fundamentals of attack and vulnerability and the theories of visual perception, it also describes the applications of these principles in practical camouflage methods. A summary of camouflage maxims and a bibliography supplement the text.

Flight and Airframes for the Aircraft Fitter, by D. O. Bishop and P. A. Bosanquet; Sir Isaac Pitman and Sons, Ltd., London, 1943; 192 pages, 10*s.* 6*d.*

Written to comply with the requirements of the general aircraft factory worker, this handbook outlines the fundamentals of airplane flight and structure. It is divided into five parts: the first discusses flight of the aircraft; the second, structure of the aircraft, and the third, aircraft hydraulic systems. Materials used in aircraft construction is the subject of Part IV; blueprints, the subject of Part V.

Airman Tomorrow, by Alfred Kerr and C. Winchester; H. F. Lucas and Company, London, 1942; 126 pages, 2*s.*

A handbook for the British youth who expects to enter the Royal Air Force. It includes information regarding ranks, insignia, rates of pay, aircraft identification, aircraft engines, elementary navigation, aerodynamics, signalling, drill and deportment, gliding, and other pertinent subjects.

Astronomical Air Navigation, by Squadron-Leader Ronald Hadingham; The Technical Press, Ltd., Kingston Hill, Surrey, England, 1943; 132 pages, 10*s.* 6*d.*

A practical course in astro-navigation, with only essential references to the mathematical and theoretical aspects. Such basic principles of navigation as are necessary to the practical applications are included, together with a certain amount of elementary astronomy.

Aero-Engine Theory Simply Explained, by Group Captain Coats; Sir Isaac Pitman & Sons, Ltd., London, 1943; 39 pages, 9*d.*

A booklet for boys in which elementary information is given about the design and performance of aircraft engines.

Air Navigation Workbook, by Lt. (j.g.) A. D. Bradley and Clifford B. Upton; American Book Company, New York, 1943; 112 pages, $0.88.

A course in graphic mathematics which provides for the topics in air navigation recommended in a recent report issued jointly by the U.S. Office of

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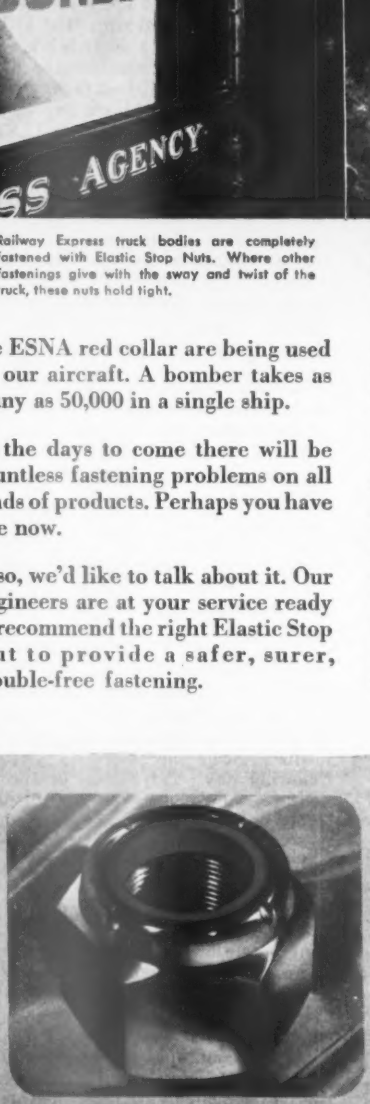

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This book is intended for use in pre-induction courses in secondary schools. No knowledge of trigonometry is required.

Introduction to Aero Engines, by "Arduus"; George Newnes Ltd., London, 1943; 144 pages, 6*s*.

Fundamental information for aircraft mechanics is contained in this book. The first four chapters deal with mechanical theories. Chapter V explains thermodynamics and the application of these theories to power calculations. Other chapters give the details of all general types of aircraft engines. Supercharging and booster control are discussed, both the Hobson and Rolls-Royce systems being described. The two final chapters give information concerning aircraft fuels and propellers.

Moderne Algebra (Modern Algebra), by B. L. van der Waerden; published and distributed in the public interest by authority of the Alien Property Custodian by Frederick Ungar Publishing Company, New York, 1943; 225 pages, $6.00.

The purpose of this book is to present the "abstract," "formal," or "axiomatic" tendency, which of late has given new impetus to the application of algebra. By creating a series of novel terms, such as "the theory of bodies," "the ideal theory," and the "theory of hypercomplex numbers," this tendency has led to new mathematical combinations and indicates far-reaching results.

Mitteilungen aus dem Institut füer Aerodynamik der Eidgenössischen Technischen Hochschule Zürich (Reports of the Aerodynamic Institute of the Federal Technical Academy, Zürich, Switzerland); Verlag A. G. Gebr. Leemann & Co., Zürich, Switzerland, 1943; 72 pages, 4.80 Swiss francs.

This book of 72 pages contains four papers by members of the faculty of the institution. The first article is titled "Aerodynamical Institute of the Federal Technical Academy," by J. Ackeret. It gives an extensive description of the laboratory, which has a conventional wind tunnel and a supersonic wind tunnel. Measuring and control devices are described in detail. In the supersonic wind tunnel, speeds twice as high as that of sound may be attained. It is stated to be the first of its kind and has served as a model for other tunnels that have since been built or are being built. Auxiliary testing devices, such as propeller motors, the towing tank, and the test turbine, are also mentioned.

The two succeeding essays deal with special measuring devices and are titled "A Special Hot-Wire Arrangement to Measure Turbulent Flow Variations," by G. Daetwyler and "A Schlieren Picture Device for Observations in the Supersonic Wind Tunnel," by P. de Haller. The fourth contribution, written by W. Pfenninger, treats the "Comparison of the Results of the Impulse Method with Those of the Balances at Drag Measurements on Airfoils."

Library Accessions

Utah Laws Governing Aeronautics, Utah State Aeronautics Commission, Salt Lake City, 1939; 30 pages.

This pamphlet on the aeronautical laws passed by the State of Utah is divided into three sections: Part I deals with public airports, Part II is called "Regulating Aeronautics," and Part III is headed "Motor Fuels."

First Biennial Report of the Utah State Aeronautics Commission, 1937–1938; Utah State Aeronautics Commission, Salt Lake City, 1939; 20 pages.

The first Biennial Report of the Utah State Aeronautics Commission, covers the period 1937–1938. It includes statements of receipts and disbursements for March 22–December 31, 1937, and January 1–June 30, 1938.

Second Biennial Report of Utah State Aeronautics Commission, 1939–1940; Utah State Aeronautics Commission, Salt Lake City, 1940; 19 pages.

The second Biennial Report of the Utah State Aeronautics Commission, for the period from July 1, 1938, to June 30, 1940, includes a statement of revenues and expenditures for that period.

Aeronautical Law, June 28, 1941; New Hampshire Aeronautics Commission, Concord, N.H., 1941; 41 pages.

A summary of the State rules and regulations governing aeronautics in New Hampshire.

Fire Protection and A.R.P. Year Book, 1940–1941, 1942–1943; Lomax, Erskine & Company, Ltd., London, 1940, 1942; 2 vols., 7*s*. 6*d*. per volume.

Two editions of the annual reference books on the British Fire Protection and Air Raid Protection Services. The yearbooks include: miscellaneous data on how to fight various types of fires; information with regard to precautions against air raids; alphabetical lists of Empire brigades and A.R.P. and N.F.S. officers; manufacturers of fire service and A.R.P. equipment; an outline of the National Fire Service organization; etc.

A Mathematical Refresher, by A. Hooper; Oliver and Boyd, Edinburgh and London, 1941; 308 pages, 9*s*. 6*d*.

Designed primarily for the use of aviation students, this is a review of arithmetic, algebraic, geometric, and trigonometric essentials. An American edition of this text has also been published.

Senior Workshop Calculations, by W. A. J. Chapman; Edward Arnold & Company, London, 1941; 432 pages, 10*s*.

One of two mathematical textbooks giving the computations necessary for Britain's City and Guilds Intermediate and Final Examinations in Machine Shop Engineering. All the calculation work necessary for Ordinary National Certificates in Workshop Technology and allied subjects is included.

Motores de Aviación, by J. Fernández Pinto; Editorial Glem, Buenos Aires, 1942; 179 pages, (pesos) $4.00.

A study of the basic principles of aircraft engines. Construction details of many engines are described and various types of fuels are discussed.

Alta Escuela, Vuelo Acrobático, by Pablo C. Passio; Editorial Pan América, Buenos Aires, 1938; 96 pages, (pesos) $3.00.

A compilation from foreign publications of suggestions on acrobatic flying.

Theory of Flight, Basic Training Manual, edited by V. A. Pope; Sir Isaac Pitman & Sons (Canada) Ltd., Toronto, 1941; 46 pages, $0.15.

A primer on the principles of flight. One of a series of manuals, prescribed for the official use of the air cadets of Canada.

Flying and Weather, Audio-Visual and Teaching Aids, compiled by Dr. Lili Heimers; New Jersey State Teachers College, Upper Montclair, N.J., 1942; 13 pages, $0.50.

Intended primarily for the students and alumni of the New Jersey State Teachers colleges and for librarians in the public schools of New Jersey, this is a tentative list of periodicals, publications, charts, maps, films, slides, film slides, recordings, and blueprints for the teaching of preflight aeronautics. It is also designed to correlate the study of aviation and weather with other courses in the schools' wartime curricula.

The Aviation Salvage at Sea Convention of 1938, by Arnold W. Knauth; New York University School of Law, New York, 1939; 23 pages, $1.00.

A report on the actions taken by the Sea Convention of 1938 with regard to aviation salvage laws. Series I, Number 18 in the New York University School of Law Contemporary Law Pamphlets.

Third Party Damage by Aircraft, British Legislation and the Rome Convention, by J. M. Spaight; New York University School of Law, New York, 1939; 28 pages, $1.00.

Number 22 in Series 1 of the New York University School of Law Contemporary Law Pamphlets has to do with laws on third-party damage by aircraft as evolved by British Legislation and the Rome Convention.

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Unit Course in Aircraft Welding, prepared for the Air Service Command U.S. Army Air Corps, in cooperation with the U.S. Office of Education, by the Utah State Board for Vocational Education, Salt Lake City, Utah, 1942; 1 vol.

A shop instruction manual, written as an aid in the training and "upgrading" of civilians employed at U.S. Army Air Depots and Sub-Depots. The twelve units of the book deal with oxygen-acetylene apparatus; welding steel and steel alloys; cutting metals by the oxygen-acetylene process; welding aluminum and aluminum alloys; welding copper and copper alloys; welding ferrous castings; brazing and silver soldering; hard surfacing; the construction of airplane structural units and parts; welding in the repair of aircraft parts; aircraft qualification job tests; and heat-treating.

Examples and Exercises in Elementary Air Navigation, by M. J. Hearley; Longmans, Green and Company, London, 1942; 32 pages, 1*s*.

Following the A.T.C. and I.T.W. syllabus, this leaflet supplies practice in the basic calculations of air navigation. It is a British publication, recommended for the use of R.A.F. air crews, Army Cooperation, and Fleet Air Arm personnel, and cadets in the Air Training Corps. Answers accompany all exercises.

Dead Reckoning Altitude and Azimuth Table, H.O. No. 211, by Arthur A. Ageton; U.S. Government Printing Office, Washington, D.C., 1943; 49 pages, $0.90.

The third edition of this table compiled by Lt. Ageton includes two additional problems to illustrate the use of the table in conjunction with the Nautical Almanac, which now tabulates the G.H.A. direct.

History of the Great War, Military Operations, East Africa, Volume I, August 1914–September 1916, compiled by Lt. Col. Charles Hordern, founded on a draft by the late Major H. FitzM. Stacke; British Information Services, New York, 1941; 603 pages, $5.50.

This volume is concerned with the first half of the East African compaign of the first World War, recording the battle proceedings from August, 1914, to September, 1916. It is based on official documents and was compiled by direction of the Historical Section of the Committee on Imperial Defense.

The Lost Diary, by Sandham Graves; Charles F. Banfield, Victoria, B.C., 1941; 131 pages, $2.00.

A journal of experiences with the Canadian Army during the first World War. There are three parts to the book: the first is called "Canada's Fighting Men, 1914–17"; the second, "Wings in the Royal Flying Corps, 1917–18"; and the third, "Mediterranean Days in the Tenth Crusade."

First Progress Report, Department of Public Works, State of Louisiana, 1940–1941; Louisiana Department of Public Works, Baton Rouge, La., 1941; 309 pages.

A report on the organization and operations of the Louisiana State Department of Public Works with regard to engineering, planning, housing, and aeronautics. It covers the period of January 1, 1940, to December 31, 1941.

Report of the Nebraska Aeronautics Commission, July 1, 1943; Nebraska Aeronautics Commission, Lincoln, Neb., 1943; 1 vol.

A review of aviation activities in Nebraska during the years 1940 through 1943, as reported by the State Aeronautics Commission. The pamphlet is divided into sections relative to aviation progress in Nebraska, accidents, receipts and expenditures, airports, future planning, "air-making," the teaching of aviation subjects in Nebraska schools, Civilian Pilot Training and War Training Service, the Civil Air Patrol, and air lines serving Nebraska.

Effect of Airport Development on Value of Adjacent Real Estate; Bulletin No. 25; National Association of Assessing Officers, Chicago, 1941; 16 pages, $0.50.

Bulletin No. 25 of the National Association of Assessing Officers contains the statements of various members in large cities of the United States with regard to the effect of airport development upon the value of adjacent properties. The conclusions indicate two general results in the majority of cases: First, there is not much change in residential real estate values from this cause, but what changes do take place are in a downward direction; second, there is frequently a slight enhancement in the value of business properties that lie directly opposite an airport and which are generally used for drug stores, taverns, restaurants, etc.

Flying Freight, by L. K. Sillcox; Graduate School of Business Administration, Harvard University, Soldiers Field, Boston, 1942; 47 pages.

A study of the factors and trends of air cargo, together with an analysis of its probable effects on future freighting. Presented as a lecture at the Graduate School of Business Administration, Harvard University, by the first Vice-President of the New York Air Brake Company.

Rules and Regulations Governing the Licensing of Airmen, Aircraft and Airports, and the Operation of Aircraft and Airports in the State of Virginia, and Statutes Relating to Aviation; State Corporation Commission, Commonwealth of Virginia, Richmond, Va., 1936, 23 pages.

This pamphlet contains a reprint of the Virginia Aviation Law and other statutes pertinent to aviation passed by the State. It includes a section defining the words used in the rules and regulations; a section dealing with the licensing of pilots, mechanics, commercial and private aircraft, airports and public landing fields; and a section covering the construction and operation of airports.

Laws and Rules and Regulations of the South Dakota Aeronautics Commission; Pierre, S.D., 1939; 75 pages.

South Dakota state regulations with regard to the licensing and operation of aircraft, airports, flight training, air traffic, etc., are condensed in this manual.

Report of the South Dakota State Aeronautics Commission; Pierre, S.D., 1942; 6 pages.

A report on the work of the South Dakota Aeronautics Commission for the period from January 1 to December 31, 1942, together with an outline of aeronautical activities in South Dakota for that year. The leaflet concludes with a recommendation that a State appropriation be made for the purposes of the Civil Air Patrol, indicating to what end the monies would be used.

Maryland Laws and Regulations Governing Aeronautics; Maryland State Aviation Commission, Baltimore, 1935; 88 pages.

A compilation of the State of Maryland's regulations with regard to aviation. For the most part, the rules follow those of the Civil Aeronautics Authority but differ in that all pilots, planes, and airports in Maryland must be licensed.

Loft Handbook, Lockheed Aircraft Corporation, Burbank, Calif., 1940; $4.00.

A loose-leaf manual on lofting. Contains formulas and data for solving lofting problems.

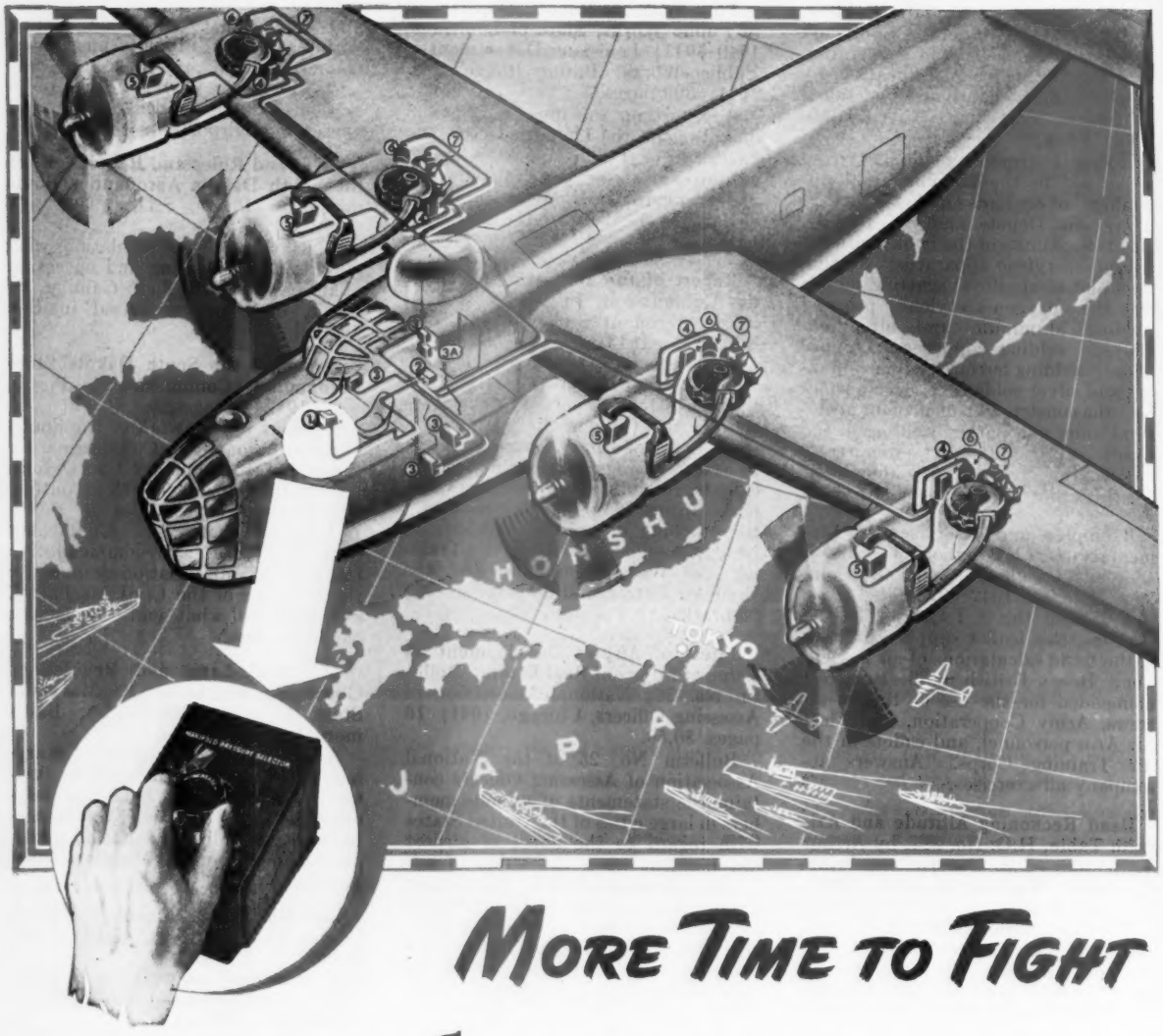
Drafting Room Manual; Lockheed Aircraft Corporation, Burbank, Calif., 1943; $5.00.

This drafting-room manual, compiled by the Lockheed Aircraft Corporation, is divided into nine sections. The first contains general information about the company. The second is devoted to a study of standard drafting practice; the third, to layout procedure; the fourth, to drawing procedure; and the fifth, to release procedure. Part six is concerned with the stock list; part seven, with specifications; and part eight, with specific procedures. Part nine deals with detail assembly templates, detail assembly-template drafting practices, and flat development.

American Air Mail Catalogue, American Air Mail Society; The Airpost Journal, Albion, Pa., 1940; 718 pages, $3.50.

The first edition of a reference and price index to the air-mail stamps of the world prepared for philatelists.

(*Continued on page 213*)



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British Air Ministry Translations

The list below supplements those published in June, September, October, and November, 1943, and January and April, 1944, issues of the *Aeronautical Engineering Review*.

Aeronautical companies and other organizations may borrow copies of these translations through the facilities of The Paul Kollsman Library upon application by the company librarian. Because of the importance of this material, the regular library loan period has been extended to two weeks, in order that these translations may be utilized to their full advantage. Requests should be made by number, author, and title on the regular Library book request cards. Because of the many requests for these translations, no more than five copies may be borrowed at one time by one organization.

The translations have been reproduced from typewritten copy and the number of pages in each is indicated at the end of each reference. Bibliographic information has been taken directly from the translations. Photostatic copies are also available at the usual library rates.

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Above view shows one of the batteries of molding presses in the ORCO plant which covers more than 11 acres of floor space.

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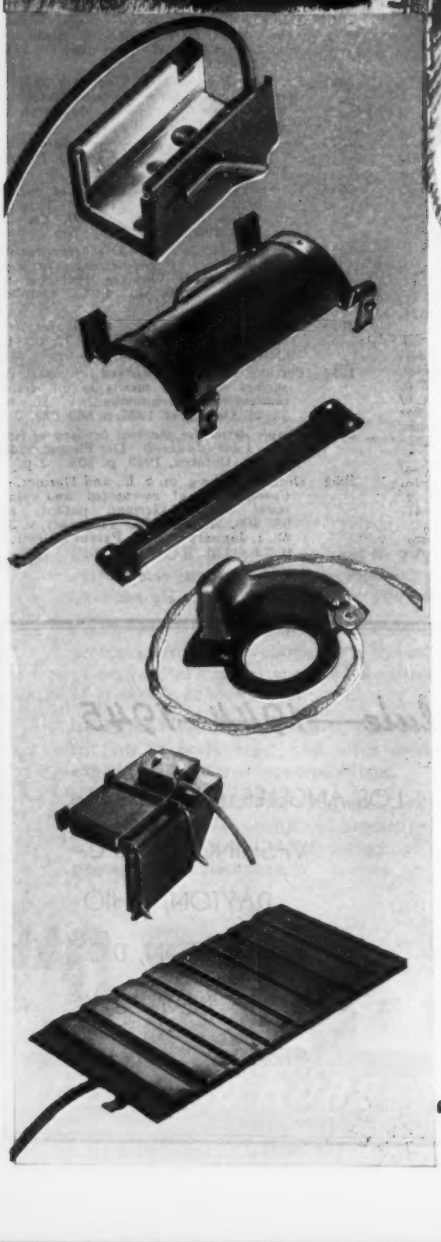
I.A.S. National Meetings Schedule—1944–1945

SUMMER MEETING	July 27–28, 1944	LOS ANGELES, CALIFORNIA
AIR TRANSPORT MEETING	September 22, 1944	WASHINGTON, D.C.
FALL MEETING	November 9–10, 1944	DAYTON, OHIO
WRIGHT BROTHERS LECTURE	December 17, 1944	WASHINGTON, D.C.
THIRTEENTH ANNUAL MEETING	January, 1945	NEW YORK
SPRING MEETING	April, 1945	DETROIT, MICHIGAN



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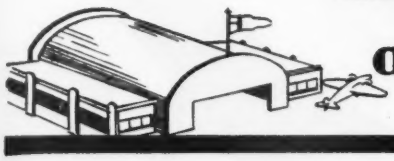

Motion Pictures of Airacobra Production, Construction, and Operation

Catalog of Films Produced by Motion Picture Division of Bell Aircraft. Films produced by the motion-picture division of Bell Aircraft Corporation are listed in this catalogue and a synopsis is given of each. Made on 16-mm. film with sound, the films fall into two classifications. Two motion pictures show the Bell organization at work, the airplanes it builds, and the people who build them. These are available to the public. The second group is a series of 29 training films concerning the P-39. Produced especially for, and with the cooperation of, the Army Air Forces, the films in this group are restricted. They are distributed only by the A.A.F. to training and operational bases for the purpose of acquainting air and ground crews with the various parts of the Bell fighter. *Bell Aircraft Corporation.*

Fluid Metering Pump Systems

Accessory Design Check Chart No. 7 of the "Eclipse Aviation Accessories Series" is a 4-page folder about pump systems providing metered flow for anti-icing and unit heaters. Included in the descriptive information are data on the applications, performance, design, and specifications of these pump systems. Drawings of the equipment are shown. *Eclipse-Pioneer Division, Bendix Aviation Corporation.*

Naval Inspection of Martin Mariners

Hedron 5-2. An article on the activities of the Baltimore Detachment of Hedron 5-2. This is the unit of the U.S. Navy charged with the inspection, testing, and acceptance of PBM-3 airplanes. Located on its own Naval Reservation near the Martin plant, Hedron 5-2 is reported to consist of 9 commissioned officers, 2 noncommissioned pilots, and a small group of enlisted men who inspect the airplane, prepare it for flight, flight-test it, and deliver it to a Navy acceptance center. In addition to notes on how they carry out these duties, the article tells about the operation of the Naval Facility on which the men live. *The Martin Star*, April, 1944.

Precision Measuring Instruments

How to Measure in Micro Inches is the title of a 20-page booklet about the uses for precision measuring instruments. The booklet gives the fundamentals of precision measurements and shows how these principles are applied to production in the daily control of product quality.

Photographs show new and useful applications for gauge blocks, vernier gauges, sine bars, master parallels, flats, and other precision measuring instruments. Charts and drawings illustrate the relationship of various dimensions as affected by the temperature of materials being measured.

The booklet tells how the engineering department and production department can work together in maintaining close dimensions in the fabrication of products and describes the way accuracy can be maintained in instruments by the use of gauge blocks and gauging instruments. One section is devoted to the care of precision measuring instruments. New gauging instruments and a new mobile inspection unit are described. *Continental Machines, Inc.*, Minneapolis.

Development and Application of Electronics

Electronic Telesis is an illustrated booklet that traces briefly the development of the science of electronics and explains some of its applications. Following a short discussion of the principles upon which electron tubes operate, a few of the current applications are reviewed. These include aircraft instruments, frequency-modulation radio, radio-facsimile reproduction, television, vacuum switches, vacuum condensers, and diathermy. How electron tubes were developed is discussed, as well as the manner in which difficulties were analyzed and corrected. The creation of the types of tubes produced by one manufacturer is emphasized. *Eitel-McCullough, Inc.*, San Bruno, Calif.

Fairchild History

Yesterday's "Touch of Tomorrow." Richard H. Depew, Jr. Part six of a continued article on the history of the Fairchild Engine and Airplane Corporation deals with the design and development of Fairchild planes after 1931. Aircraft discussed are the "light attack" version of the KR-34; "22" series; "24" (UC-61) series; "C-31"; Model 91 "Baby Clipper"; "45"; "46"; "M-62" (PT-19); and AT-21. The subcontracting work being done at Hagerstown for The Glenn L. Martin Company, the other companies building the AT-21, and the expansion of the Ranger Engines Division at Farmingdale, L.I., are noted. *The Pegasus*, May, 1944.

Data Concerning Pioneer Instruments

Additional sections for the technical data files concerning Pioneer aircraft instruments have been issued as follows:

Service Bulletins: *41-13E*, How to Balance the Gyro and Make Weight and Damping Adjustments on the Turn and Bank Indicator; *41-14B*, Cleaning Diaphragm Assemblies of Manifold Pressure Gauges; *41-20*, Insulating the Hairsprings of the Pioneer Gyro Flux Gate Compass Transmitter; *41-14C*, Cleaning Diaphragm Assemblies of Autosyn Manifold Pressure Transmitters; *41-27*, Installation of BJ6 Averaging Device in Sextants; *42-16A*, Modification of Demand Oxygen Regulator for Low-Pressure Operation; *42-18*, Lubrication Recommendations for Pioneer Instruments.

Overhaul Manuals: *32-2C*, Inverters; *41-6A*, Centrifugal Tachometers; *310-4* and *312-6*, Sensitive Altimeters; *312-8F*, Electric Tachometer Alternators.

Test Procedure: *41-11A*, Autosyn Tachometer Transmitters; *41-14D*, Suction Gauges; *41-20A*, Autosyn Oil or Hydraulic-Pressure Transmitters; *41-24*, Autosyn Manifold-Pressure Transmitters; *41-24A*, Autosyn Differential Fuel Pressure Transmitters; *310-18A*, Vaporproof Manifold Pressure Gauges; *312-4*, Direct-Reading Magnetic Compasses; *312-18*, Oil-Pressure Warning Units; *312-18A*, Autosyn Liquid Level Transmitters.

Test Equipment: *312-2B*, Barometer; *312-2C*, Pelorus; *312-2D*, Demagnetizer; *312-2F*, Range and Balance Stand; *312-2G*, Millimeter Test Stand; *312-2H*, Rack and Vibrator; *312-2J*, Pitot-Static Tube Heater Tester; *312-2K*, Turn and Bank Stand; *312-2L*, Ball Bearing Test Stand; *312-2M*, Airspeed Manometer; *312-2N*, Tachometer Test Stand; *312-2P*, Three-Unit Bell Jar; *312-2Q*, Dead Weight Tester. *Eclipse-Pioneer Division, Bendix Aviation Corporation.*

National Aircraft Standards

National Aircraft Standard NAS D-590 comprises six sheets of blueprint containing an alphabetical index of Boeing Aircraft Company standards. The list gives the name and number of each standard and remarks concerning applications of the standard and numbers replaced or superseded.

NAS 35 applies to a cable-pulley lock for $^{3}/_{32}$-in. diameter engine-control cable. NAS 177 and 178 apply to Hi-Shear rivet pins and NAS 179 applies to a Hi-

HOW *Many* TOMORROWS MUST PASS...?

● A family heliocopter—just right for the old garage, opening up to full size, with no bothersome wheels and just 2 propellor blades . . .

How many tomorrows before this comes to pass? Frankly, Haskelite will not prophecy. But we do know that developments like these are *evolutionary* — not revolutionary. The engineering inventiveness that first designed the heliocopter will gradually develop this ship to the point where it meets popular fancy.

Whatever the trend of tomorrow's planes may be, Haskelite materials will have a place in them, because Haskelite has gained general acceptance as a basic plane material. This has come about through engineering co-operation between our engineers and the builders. Haskelite's skilled engineers are ready to help *you* with any problems involving the possible use of Haskelite materials. Feel free to call on them at any time.

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HASKELITE PLYMOLD
A new technique in the mass production of molded plywood for lightweight but precisely engineered construction, by which veneers are cross laminated over easily fabricated dies in simple or compound curvature—in small sizes or in sections as large as a bomber fuselage.

AIRCRAFT PLYWOOD
In Plymold shapes or in panel form, Haskelite Aircraft Plywood has qualities to particularly suit it to aircraft construction requirements: great strength, low density, etc.

OTHER HASKELITE LAMINATES
Haskelite also manufactures fabric and paper base laminated phenolics for special aircraft uses requiring high-strength properties.

HASKELITE
Aircraft PLYWOOD

shear rivet collar. *National Aircraft Standards Committee.*

Selecting Propellers for Newly Designed Aircraft

Installation Engineering. A description of the duties of the Installation Engineering Department at the Curtiss-Wright Propeller Division and the methods by which the department functions. Reviewing the factors that dictate the airplane manufacturer's selection of a particular propeller, the article shows how the propeller-installations engineer helps him in arriving at a final decision. The procedure is exemplified by a hypothetical installation. *The Bladesman,* March, 1944.

Aviation Petroleum Products

Characteristics and Tests of Esso Aviation Products. General Information about aviation petroleum products is given in a 26-page booklet. To give a clearer understanding of the finished products, the first section of the publication contains an outline of the origin, nature, and production of petroleum. The second section deals with the properties and uses of the finished products, which include aviation gasoline, engine oil, hydraulic oils, grease, specialty oils, and corrosion preventives. Typical inspection data on some aviation products are contained in an appendix. *Standard Oil Company of New Jersey.*

Plastic Housings for Power Machines

Tools to Build the World of Tomorrow. This brochure describes the history, development, features, and advantages of portable power tools housed in plastic. It also contains descriptive details and specifications of the plastic-housed portable electric drill recently introduced by the makers of Thor tools. *Independent Pneumatic Tool Company,* Chicago.

Production Improvement Bulletins

Production Improvement Bulletin No. 96 explains the operation of an air-operated automatic dimpling trip. The device is intended to avoid spoilage if an operator is too hasty in tripping a dimpling machine when the stock is not quite centered. It also enables a new operator to work almost as rapidly as one with considerable experience. Instructions are given for making and using the device with a machine not equipped with a built-in control for this purpose.

Bulletin No. 97 shows a joggling die, operated by a pneumatic compression cylinder and equipped with interchangeable die blocks. It can be used for joggling extrusions of different metal thicknesses and different depths. *Bulletin No. 98* illustrates gauges for a rotary file and grinder by means of which a fast and accurate method is provided for gauging the material to be removed from a part by a rotary file. *Curtiss-Wright Corporation, Airplane Division.*

SAE Aeronautical Standards, Recommended Practices, and Aeronautical Information Report

Seven new aeronautical standards and recommended practices and one revised aeronautical standard have been issued as follows: involute splines; aircraft air-conditioning equipment nomenclature; inboard thread protector cap for dual-propeller shafts; aircraft oxygen equipment nomenclature; preparation of service bulletins for aircraft engines; tables of limits, and limits and lubrication charts; operating instructions for aircraft engines; and single-rotation propeller hub. *Society of Automotive Engineers, Inc.*

Merchandising Principles

The Operation of Your Aircraft Accessory Business Now and Post-War. This bulletin advises aircraft operators on merchandising principles for building up their accessory and parts business. Suggestions are given with regard to the market, correct sources of supply, a balanced adequate inventory, the store or department, and sales and display methods. *Scott Aviation Corporation,* Lancaster, N.Y.

Aircraft Accessories and Components

Simmonds Products Fly with Famous Planes. An illustrated leaflet offers some data about the products, facilities, and manufacturing standards of Simmonds Aerocessories Inc. In addition to describing briefly past aeronautical developments sponsored by the company and some of its present manufacturing and engineering activities, the pamphlet also indicates its plans for peacetime service. *Simmonds Aerocessories Inc.,* New York.

New Insulator

Specifications for a new insulator are given in a page, issued for inclusion in the manufacturer's catalogue of "3-M Adhesives for the Aircraft Industry." The properties and characteristics of the material are given. It is designated as EC-741, a lightweight, spray-on insulator for use over heater ducts, over oil tanks, and as a sound and heat insulator for sections of an airplane fuselage. *Minnesota Mining & Manufacturing Company,* St. Paul.

Operation of Air Services by Surface Transportation Companies

Congress Should Not Prohibit Air Bus Service. In a 16-page pamphlet clarifying their position, the intercity bus industry challenges the Civil Aeronautics Board report that recommended that surface transportation companies should not be permitted to operate air service and that applications for such service involving the use of helicopters should not be heard until such time as this type of aircraft has been proved practical for commercial air transportation. The bus companies argue that: air service is needed for transport operations of 50 to 250 miles; fixed-wing aircraft cannot compete with the automobile for this type of traffic but the helicopter can; the helicopter should be coordinated with bus transportation having downtown terminals and reaching surrounding communities by motorbus service; air-bus service would supplement both existing air and bus service, competing with neither; bus companies are best fitted to supply service because of their existing facilities; it is in the public interest to have bus companies provide this service, since they are willing to enter the field without subsidies. *National Association of Motor Bus Operators.*

Cameras for Aircraft Engine Testing

The Camera Catches Up. An account of how high-speed motion-picture photography facilitates the inspection of aircraft-engine parts operating at full power. Slow motion projection permits the engine technicians to study test runs. Initially used for recording occurrences in the single-cylinder experimental test cell, the camera is reported to be particularly helpful for analyzing oil flow, cylinder-head fin vibration, the effects of entrained air on oil-pump performance, and valve-mechanism performance. *Trade Winds,* February, 1944.

Postwar Air Travel Booklet

Tourist Travel Blacked Out for the Duration. . . Pan American-Grace Airways has issued a booklet forecasting the postwar air travel trend to South America. In addition to giving a digest of the company's proposed plans for future operations, the booklet reviews Panagra's 15-year history. A map illustrates present and proposed operations. Speedier services that will be made available after the war by the use of four-engined planes are discussed. Photographs accompany descriptions of eight of the South American countries. *Pan American-Grace Airways, Inc.*

Revisions for Engine-Overhaul Manual

Revised sheets have been issued for pages 51, 52, 112, 121, 122, and 123 of the *Overhaul Manual* for Jacobs Models L-4MB and L-6MB aircraft engines. Pages 51 and 52 replace similar pages of Section VII, Repair and Replacement and Assembly, and pages 121–123 supersede like-numbered pages in the Table of Limits. *Jacobs Aircraft Engine Company,* Pottstown, Pa.

Airacobra Landing Gear

Landing Gear Builders. The work of Department 83 of Bell Aircraft's Niagara Frontier Division is outlined. In this department Airacobra tricycle landing mechanisms are built and assembled. The article contains some brief comments on how the worm and sector of the main landing gear are fabricated, how the spindle assembly is constructed, and how the parts of the gear boxes and controls are assembled. It also includes some descriptive details on the mechani-

Up where Uncle Sam's high-altitude bombers and fighters are pushing to new and greater heights, Packard high-altitude ignition cable is "carrying the current" that keeps powerful engines roaring with life. It's tough going up at the top, but Packard high-altitude ignition cable's tough synthetic rubber sheath, over an inner reinforcing braid, provides effective protection against extreme cold, heat, oil, moisture and electrical corona. This ability to triumph over stratospheric flying conditions makes it an outstanding cable for *any* altitude, in any part of the world. It is the result of years of constant research and development . . . just one of many types of Packard cable staunchly serving America's fighting air forces and aircraft industry. Whatever the need—you're RIGHT with Packard cable.

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PACKARD CABLE SERVES THE ARMED FORCES
on trucks • jeeps • tanks • armored cars • planes • aircraft instruments • anti-aircraft gun controls • landing boats • radio equipment.

ARMY E NAVY

cally operated tricycle landing gear. *The Bellringer*, May, 1944.

History of Air Express

Vision Unlimited. The development of commercial air transportation in America is outlined. In booklet form, the highlights of air express history are reviewed from the pioneers of 1910, through the early days of scheduled air freighting in the 1920's, to the role that air express is playing in the war. Charts showing the growth in number and weight of shipments explain why it has been possible to decrease the rates for air express. Commodities that are shipped by air are listed, the flow of air traffic along domestic trade routes is illustrated, and predictions are made with regard to the future of air transportation. *Railway Express Agency.*

How One Company Handles Contract Termination

Company Procedure for War Contract Termination. A plan is presented for the organization of company procedures and personnel to handle war-contract terminations. As evolved and utilized by Lyon Metal Products, the pattern of coordination for compiling claim figures and data is outlined. The pamphlet gives a suggested breakdown of termination duties by departments, sets time limits for each department, and illustrates 14 forms for expediting the work. *Lyon Metal Products, Inc.*, Aurora, Ill.

Aerial Gunnery

Computing and Compensating Sights for Aerial Gunnery. Major Gen. Follett Bradley. This article deals with problems of flexible aerial gunnery from bombers against enemy fighters. It is stated that flexible aerial gunnery is subject to errors caused by muzzle velocity; weight, shape, and type of bullet; condition of the bore; type, design, and condition of the mount; vibration and rigidity of the airplane; drift and external wind; air resistance; speed and direction of movement; target speed and path, and direction of movement; position of target in azimuth and elevation; gravity drop; and range. Types of computing and compensating gun sights are described.

Gunnery training programs are discussed. It is stated that an up-to-date program for gunners must include movies, lectures, demonstrations, and practice; synthetic devices for familiarization with the use of the sights; position firing; tracking in airplanes at high altitude with camera guns against fighters attacking on the pursuit curve and flying straight courses; tow-target firing; and firing from airplanes at low altitude against the shadows on the water of attacking fighters. *Sperryscope*, April, 1944.

Aluminum Alloys

Red-X Aluminum Alloys. The characteristics, properties, and applications of Red-X (reduced expansion) custom-made aluminum alloys are described in

sheet metal products

Electronic Boxes · Welded Assemblies made to your *Exact Specifications*

We supply many of the country's leading prime contractors with quantity production of stamped—drawn—welded—sheet metal boxes, housings, tubes, tanks, straps, and fittings. Intricate assemblies involving problems found difficult or impossible by others have been successfully solved and successfully produced by Standair. Fabrication problems also are considered and often simplified. Standair is equipped to meet high output schedules —economically. Write us regarding your requirements, or send us your specifications for estimates. If you have development and design problems, either on today's jobs or on those being planned for tomorrow, Standair engineers will be glad to work with you to help you.

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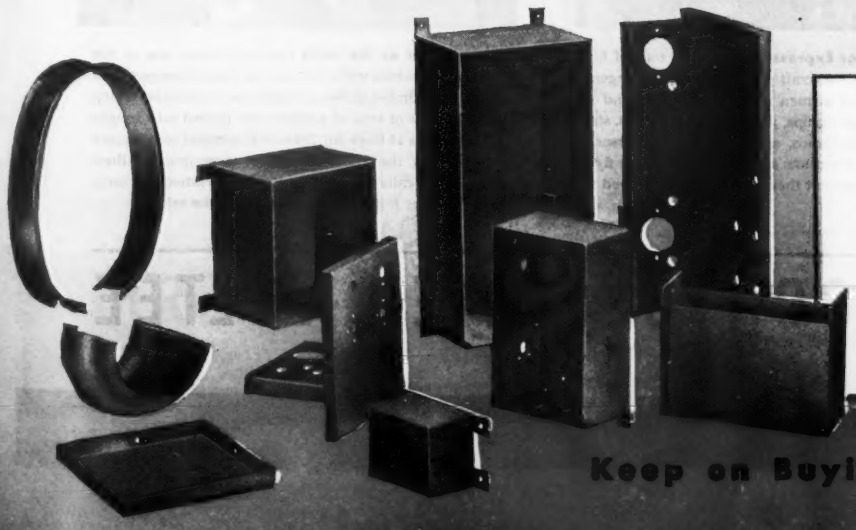


FROM RAW STOCK *to finished product by draw method, we are equipped to produce a simple job requiring a single operation or one requiring several drawing operations. 17 years' experience in metal working and stamping—all metals.*

Keep on Buying War Bonds!

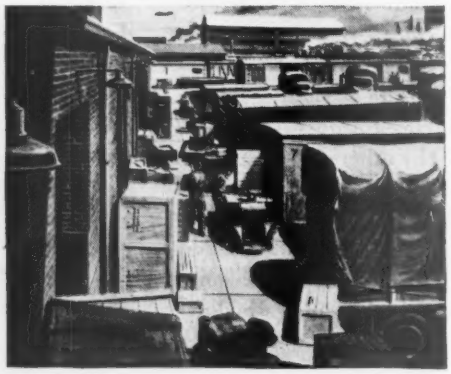
This advertisement is one of a series which is appearing in national magazines and newspapers as Consolidated Vultee's contribution toward a clearer public understanding of transportation's role in the war, and its postwar opportunities and responsibilities.

4 days out—4 days back—and the weather be damned!

1. **"Tired? I'll say I am!** You'd know, if you'd ever flown a 200-mile-per-hour cargo plane in from the Orient for the Air Service Command." He was only 22 years old, this Liberator Express pilot. He'd just brought his ship in – the end of a round-trip run on the longest air-freight haul in the world. From India, 14,000 miles away, to Patterson Field, outside Dayton, Ohio!

2. **Day in, day out,** the huge, long-range Liberator Express transports roar down this Ohio runway and streak southward to Brazil's hump, then across to Africa, and on to the very fringe of Jap-held Burma. The boys who fly this shuttle run – in all kinds of weather – call it the 8-day "Pony Express," – 4 days out, 4 days back.

3. **Each Liberator Express** carries many tons of high-priority cargo – aircraft parts and supplies urgently needed by American airmen based halfway around the world. Magnetos, fuel pumps, jungle kits, propellers, starters, aircraft engines, radios, and other vital accessories. "It's a rugged run," the pilots say. "But our combat flyers are doing a terrific job out there – and how they need the stuff we take 'em!"



4. **Dramatic as the India run is,** it's only one of the ways in which we're solving the stupendous problem of supply for United States air bases the world over. Every day, thousands of tons of supplies are loaded into freight cars and trucks at huge Air Service Command warehouses scattered over the U.S.A. The furious tempo of Allied aerial warfare calls for miracles of transportation, not only by air, but over highway, by rail, and on the sea.

CONSOLIDATED VULTEE

5. **Boxes and crates,** brought by truck and train, are lowered into the holds of waiting ships. Often, part of the cargo consists of fighter planes which have been flown from factory to dock. Partly dismantled, they are lashed down on girder-like false decks for delivery overseas. Our constant and gigantic torrent of transoceanic shipping is truly a bridge of supply which is taking us closer and closer to Victory.

6. **The plane,** the train, the truck, and the ship must team up together to help rebuild the peacetime world, just as they are working together to win the war. In fact, transportation will be a vital key to postwar peace and prosperity.

But the plane will also have a *second* role to fulfill. For the long reach and overwhelming might of American air power can well become this freedom-loving nation's most effective force for ensuring a lasting peace.

Quick Facts for Air-Minded Readers

New role for the "Cat" — Although designed as a Navy patrol bomber, the Consolidated Vultee long-range Catalina flying boat is also being used as a transport, flying natural rubber out of South America.

• • •

How your War Bonds buy more Bombers — In the 1943 fiscal year Consolidated Vultee has made savings of $251,000,000, which have been passed on to the government in voluntary cash refunds and price reductions and reserves for further refunds. This saving came about through new operating economies and efficient use of manpower, which enabled the company to turn out *more* planes for *less* money

• • •

North Atlantic Shuttle — It is reported that flights across the North Atlantic, in both directions, are now running more than 1000 a week.

• • •

For Distinguished Service — Though operating with only about half their prewar equipment in '43, the airlines of America flew 37,639,000 ton-miles of mail (*a gain of 78%*) . . . 15,774,000 ton-miles of express (*a gain of 34%*) . . . 1,540,000,000 passenger miles (*a gain of 10%*).

Consolidated Vultee is the largest builder of airplanes in the world.

No spot on earth is more than 60 hours' flying time from your local airport

From "Flying Jeeps" to Leviathans of the air — *The planes shown below were all designed and developed by Consolidated Vultee. When peace comes, the company will be in a position to provide the postwar equivalent of such planes, from small, privately owned "air flivvers" to huge, transoceanic cargo-and-passenger planes.*

AIRCRAFT

San Diego, Calif. · Vultee Field, Calif. · Fairfield, Calif. · Tucson, Ariz. · Fort Worth, Texas · New Orleans, La. · Nashville, Tenn. · Louisville, Ky. · Wayne, Mich. · Dearborn, Mich. · Allentown, Pa. · Elizabeth City, N. C. · Miami, Fla.

Member, Aircraft War Production Council

OPERATES POSITIVELY FROM A MOMENTARY IMPULSE

A SMALL "MEMORY-TYPE" RELAY

with R-F INSULATION

Originally designed for aircraft services, this new Struthers-Dunn 50XBX "Memory" Relay is ideally suited for numerous other applications as well. It is of two-coil, latch-type construction, having radio frequency insulation on its double-pole, double-throw main contacts. These contacts operate immediately upon receipt of a momentary impulse from a push button, limit switch, or any other source of brief or extended impulses.

The coils are practically universal in that they will operate on voltages as low as 12-volts D.C. Since they are in the circuit only momentarily, they cannot overheat on much higher voltages, nor will they hum or overheat on A.C. as each coil may be connected to de-energize itself as soon as it has performed its function.

Struthers-Dunn Type 50XBX "Memory" Relays will operate in any position, are shock-proof to 10 G's, and set new standards of efficiency on applications where the contacts must "remember" unfailingly which coil was last energized—by remaining latched in position until they are released by energizing the other coil.

STRUTHERS-DUNN, INC., 1321 ARCH ST., PHILADELPHIA 7, PA.

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5,288 RELAY TYPES

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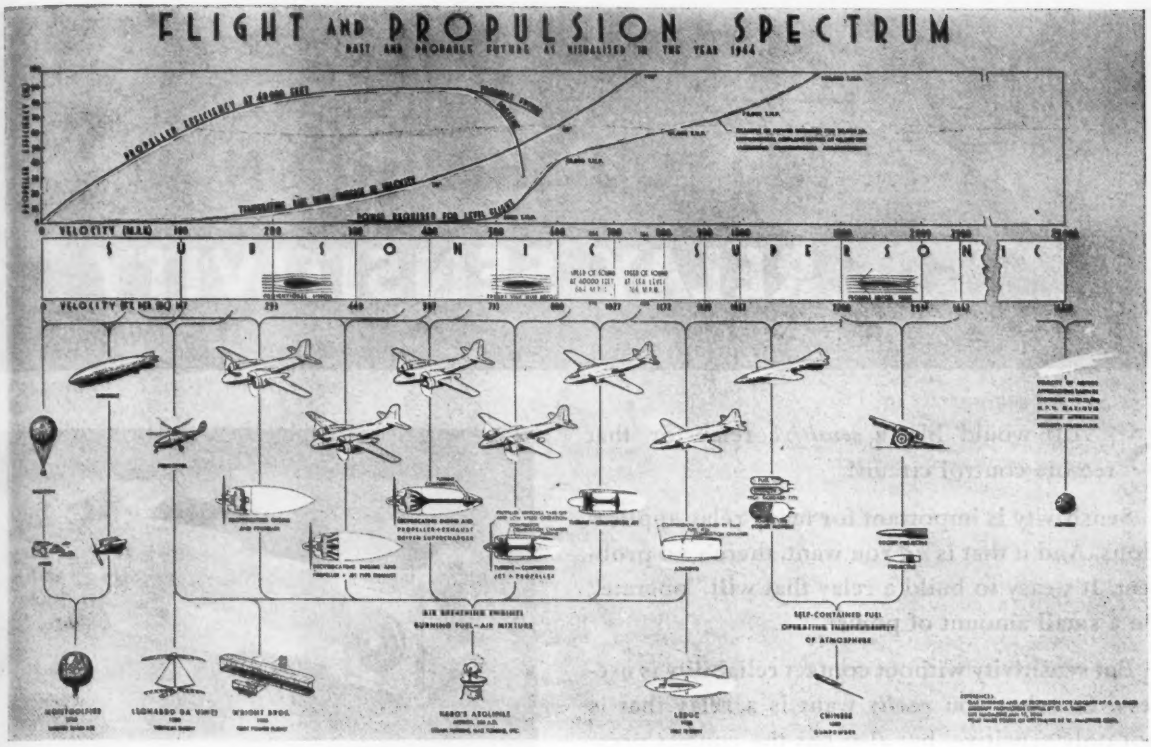


A pictorial presentation of flight and propulsion, giving past performances and suggesting possible future developments. (*Reproduced through the courtesy of the Douglas Aircraft Company, Inc.*)

a 16-page pamphlet. This folder also depicts how the alloys are produced and cites their advantages to the engineer, the foundry, and the machine shop. *The National Smelting Company*, Cleveland.

Air Transport

The Spring issue of *The Index*, quarterly publication of the New York Trust Company, gives a financial analysis of the air transport industry and its prospects. There are two parts to this issue. Part I deals with the domestic aspects of air transportation. It briefly investigates the development of air transport in the United States as affected by the awarding of air-mail contracts, operations during the decade of the 1920's, the promotion of passenger traffic, the second World War, the Civil Aeronautics Authority, and the Air Transport Command. It also tabulates the history of air lines in the United States through the years 1926–1943 in terms of number of operators, planes in service, miles flown, passengers carried, passenger-miles flown, express carried, and mail pound-miles flown.

In Part II problems of the future are discussed under specific headings: freedom of the air, international competition, British policy, potential expansion, freight or express service, passenger service, problems of manufacturers, and reconversion. The analysis concludes with a summary of general trends for the more immediate future. *The Index, Parts I and II*, Spring Issue, 1944.

SAE Aeronautical Material Specifications

Four new specifications and nine revisions of former specifications have been published as follows: antiseize compound (white lead base); insulating and sealing compound; synthetic-rubber binder oil resisting gaskets; bronze castings; high-strength manganese bronze castings; aluminum-bronze castings, as-cast; low-carbon steel sheet and strip; pearlitic malleable iron castings; nickel-chromium carburizing steel. *Society of Automotive Engineers, Inc.*

Janitrol Combustion Type Heaters

Surface Combustion Heaters. Four bulletins giving information about Janitrol Combustion Type Heaters are available.

Form No. PR-1-1-44 describes the operating principles of the company's aircraft heaters; *No. 3-44* contains the engineering specifications of the aircraft heaters; *Form No. 50A02* tells of the application of Janitrol Heaters to patrol rescue boats; and *No. GH-1-44, GH-2-44* is a specifications-and-instruction bulletin on the Janitrol portable ground heater. The engineering specifications leaflet on aircraft heaters gives the combustion-air regulations and ignition details for the standard vaporizing or spray-type models in the 15,000, 50,000, 100,000, and 125,000 B.t.u. capacity heaters. It also provides data on proposed installations. *Surface Combustion*, Toledo, O.

Pyrometers

The Leeds & Northrup Company has revised its Micromax rayotube pyrometer catalogue. Embodying basically the same engineering descriptions as were presented in the 1941 publication, this new edition includes additional data on equipment for measuring the temperature of molten cast iron, electric salt pots, and blast furnace stove domes. *Leeds & Northrup Company.*

Power Booster

Hydraulic "Follow the Leader." A description is given of the Vickers power booster for the flight controls of large aircraft. A diagram shows the system as applied to the elevator surface of a large airplane. A schematic drawing of the installation also is shown. *Sperryscope*, April, 1944.

Production Suggestions

More Than Wishful Thinking! The following suggestions won awards: (1) A suggestion to reroute and shorten electrical flexible conduit for hydromatic pump block attached to the airplane fire wall saves critical material and cuts assembly time. (2) Elimination of asbestos seals and redesign of side panels on carburetor air preheat box. (3) Coating of calcimine and silicate of soda protects Kirksite kettles over a period of months. (4) Form and procedure for eliminating investigation of critical shortages, cancellations, and changes. (5) A special jig for drilling

Facts YOU SHOULD KNOW ABOUT RELAY SENSITIVITY

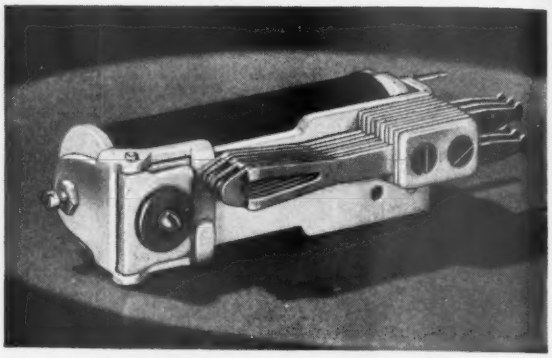
SO YOU would like a *sensitive* relay for that remote control circuit!

Sensitivity is important for many relay applications. And if that is *all* you want, there's no problem. It's easy to build a relay that will "operate" on a small amount of power.

But sensitivity without contact reliability is useless. So what you *really* want is a relay that is not only sensitive, but also has the contact pressure needed for reliability under actual service conditions.

Sensitivity and contact reliability are opposing factors. To get a high measure of both qualities in one relay calls for an exacting balance between electrical, mechanical and magnetic design factors. We've been building such relays for years —to meet hundreds of requirements, from complex telephone switching circuits to simple control functions on aircraft and radios.

Next time you need a *sensitive* relay, let the Automatic Electric field engineer show you how to get sensitivity *plus* contact reliability. No matter what the nature of your problem, there is an Automatic Electric relay that will give you both.



The Automatic Electric Class B Relay shown here combines high sensitivity and contact reliability. It has a highly efficient magnetic circuit, long wearing mechanical structure, independent twin contacts, and capacity for any number of springs up to 26. Contact pressures average 20 grams per contact. Compare this with "sensitive" relays having contact pressures of less than five grams.

For high sensitivity and contact reliability in small space, your best bet is the Class S Relay shown here. Especially designed to meet the severe conditions of operation on fast modern aircraft, it is also recommended where space is at a premium. Because of the great demand for Class S Relays for vital war products, we urge that you avoid its use except where no other relay will serve.

Relays AND OTHER CONTROL DEVICES *by* AUTOMATIC ELECTRIC

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1033 West Van Buren Street • Chicago 7, Ill.
In Canada: Automatic Electric (Canada) Limited, Toronto

and boring wing-assembly jigs makes possible all drilling or boring at once, cuts down rework, and saves time. (6) A cargo-door rod assembly results in cheaper manufacturing methods, eliminates time in assembly setting and reshaping. (7) A bomb-rack inspection fixture enables one person accurately to test bomb racks. (8) Special core drill, incorporating a pilot, aids in drilling of lever assembly. (9) Suggestion for conserving time and material in the placing of insiginia on the C-47. (10) Taking plaster castoff production pattern when inspecting matrix check gauges for rough castings aids inspectors and produces identical patterns. (11) An anodic skin rack, a methods improvement, and a new-type skin clamp and holder prevents scratching and burning of skins that are being anodized. (12) Special spray gun attachments facilitate painting of small parts. (13) Procedure for setting hydraulic-brake offsetting mechanism to avoid brake locking. (14) Frame spacers and pin for holding and separating parts subjected to heat-treatment. (15) Method of setting drift sights more accurately results in fewer compass rechecks. (16) Special clamp used for locating and drilling near gunner's escape hatch intercostal assembly eliminates work of one person and saves time. (17) Special locating fixture for installation of an electronic device enables scrap materials to be used and requires one man instead of two to do the job. (18) Tool for holding nut plates saves time and labor. (19) A set of power brake dies, consisting of twelve different sizes, for scarfing tapered flanges replaces manual labor and yields truer radius. (20) A jig for cutting special-sized holes in weather-stripping of lower nose tunnel. *Douglas Airview*, April, 1944.

Noorduyn Employee Suggestion Plan. Suggestions that won awards are: (1) A hydraulic-press method of straightening landing gear forks eliminates the use of oxygen and acetylene for heating the leg as well as the subsequent heat-treating, sand blasting, and cadmium plating. (2) Covers for protecting the machined surfaces of knee castings are applied easily and quickly and eliminate the use of masking tape and paper. (3) Special clamping device for joining two cowling sections together tightens the skin to the angle and gives the correct spacing from the location of holes. (4) By shortening the floor boards two inches, a design change is made which simplifies the installation of the lines leading to the master brake cylinder. (5) A special jig for use in soldering wires to Breeze connectors prevents the solder from running down the connector tubes and interfering with the insertion of the plugs. (6) A method for assembling electrical systems before installing them in the aircraft wings speeds production. *Noorduyn Tale-Spin*, April, 1944.

Production Time Savers. The following suggestion won an award: An improved process for fabricating and assembling fuel-tank covers reduces scrap waste to a minimum, results in interchangeable installations, and takes less than one-fourth the operating time required for the former process. *The Bellringer*, May, 1944.

Five Men Win Top Prizes for January Winning Suggestions. The following suggestions won prizes: (1) special surface grinding machine; (2) improved scribing device for grid machine; (3) a pneumatic rivet squeezer to facilitate installing snap fasteners; (4) improvement to cutters used on countersinks; and (5) improved tow-target installation. *The Chance Vought News*, April 6, 1944.

2 Win $100 Awards: 13 Share $345. Awards were made for the following suggestions: (1) Attachment for grinding of serrating mill cutters and circular thread chasers. (2) Minor redesign of drill results in a greater tolerance for drilling of rivet holes in airplane-tank panel. *The Consolidated Vultee Volunteer*, April 14, 1944.

Production Ideas Bring Cash to Four Northrop Factory Workers. Suggestions won awards as follows: (1) Improvement on the Cerro-Matrix tie method. (2) A hydropress shrink block. (3) A universal saw fixture for replacing pin router jigs. (4) Check fixture for inspecting pin router jigs. (5) A leveling plate for setting up rough castings preliminary to precision inspection. (6) A new type of saw cutoff fixture. (7) Improved side roll for extrusion power rolls. (8) An automatic Dzus button installing machine reduces hours necessary for completion of job to one-third of former time. (9) A punch-die innovation using the Wales strippet punches almost completely eliminates rework and breakdown of dies. *The Northrup News*, March 29, 1944.

Ideas Fight for Victory, Too. . . (1) An alignment tool made of stretched steel piano wire for checking wing assemblies; (2) tool for installing a rubber vibration-absorbing mounting for aircraft engines, radio equipment, etc.; (3) jig for checking landing-gear slide travel; (4) mandrel for reaming the landing-gear slide; (5) portable radial drill used for drilling holes in sheet-metal templates; (6) fixture for holding a fire-wall assembly while work is being done on it. *The Beech Log*, March 31, 1944.

$184 Worth of Runs, 27 Hits. A group of prize-winning suggestions includes the following: (1) A setscrew to regulate the travel of the crosshead on the Warner & Swasey turret lathe; (2) punch and die for punching door-latch hole in an "L" channel; (3) jig for installing the wing deicer boot prevents tearing the boot, eliminates prepunching the screw holes, and gives an even stretch; (4) jig for use in wiring generator-control panel boxes; (5) clamp or clevis for holding the nose of the wing-root rib in position on the jig; (6) an awl that hooks on to an electric drill and cuts holes in upholstery installations; (7) devices for inserting pyralin discs in sockets of control-panel knobs, before and after installation; (8) a metal bulkhead support eliminates use of wooden supports, which often slip out of position. *The Beech Log*, April 28, 1944.

Men of Fort William Plant Spark Ideas. Prizes were given for the following suggestions: (1) Fixture for routing machine which enables it to perform work ordinarily done by the sparmiller. (2) A device used in the welding of engine-mount legs facilitates the positioning of the object to be welded. (3) A rotary jig for welding results in a yearly saving of time estimated at $794. (4) Adaptation of Verson press for punching holes on material that ordinarily would require a larger throat clearance than is available on standard presses. *Canadian Car Journal*, April, 1944.

Fair Sex Rout Men Workers from Suggestion High Spot. The following suggestion won an award: (1) Testing device for fuel-cell fitting assemblies. *North Ameri-Kansan*, April 21, 1944.

Suggestion Award Winner's Logical Idea Eliminates Complete Roller Operation. Awards were given for the following suggestions: (1) elimination of a full operation on the Farnham roller; (2) special wood block for closing gaps between angles in fin beam; (3) installation of stops on jigs to eliminate elongated tooling holes. *Convair News*, April 28, 1944.

Suggestion Winners Awarded $2000; Five Share Top Honors for February. The following suggestions won prizes: (1) improved forming die for main beam angles; (2) trimming tool for angles; (3) method for eliminating rework on certain fittings. *The Chance Vought News*, April 27, 1944.

Ideas in April Bring Awards to 131 Workers. The following suggestions won awards: (1) Improved method of rigging engines saves $13\frac{1}{2}$ man hours per bomber, eliminates rework, requires less workers, reduces tool and equipment breakage, and saves material. (2) Substitute material for leather used for boots on universal joints. (3) Revised method for the operation of the airplane's oxygen system. (4) Locating jig-assembly clamps, used on main wing panel. (5) Nut plate pressure pad. (6) Device for holding intercostals to formed angles while ercoing. (7) Air hammer punch and trim device for bonding braid when trimming. *Long Beach Airview News*, May 2, 1944.

Hawkins Wins Suggestion Award. Prizes in a monthly contest were won for the following: (1) double-position expansion bar for torque-tube assembly; (2) elimination of one operation in hinge-plate manufacture resulted from reworking of a machining jig to incorporate bushings; (3) suggestion for eliminating an angle cut on certain stringers. *McConnell Bulletin*, April 28, 1944.

(*Continued on page 213*)

LAYING EGGS WITH SPLIT SECOND TIMING or HOW A BOMBER DROPS A BOMB

Only forty-five seconds for the run! The bomb sight is set and the bombardier waits for two hairs in the sight to cross. Here's what happens when the hairs cross and it's all done automatically—an electric eye winks and in one 1/50th of a second, little mechanical fingers on each bomb shackle open and *the bombs are away!*

This is precision bombing. Everything must function with infinite speed and accuracy, and if those fingers on the shackles miss their timing the salvo is a miss. Few people know about the importance of these little metal fingers weighing only a few ounces, that hold a bomb which may weigh a ton.

Small, but sturdy fingers holding tons regardless of bumps and shocks, holding the bomb until that vital split second when they open and the bomb is dumped. This bomb shackle mustn't shake, it mustn't break. It must function in all kinds of weather and temperatures. It's a precision instrument that can't be babied once it's installed—a delicate little piece of mechanism having the strength of a steel base.

In the last two and a half years Pollak has delivered thousands of these bomb shackles and other war equipment to our Armed Services for which we have received the Army-Navy "E" and four stars. This is our job now, but when peace comes we will again be manufacturing parts and products for other companies. If there is a possibility that you may need a part or an entire product developed or manufactured for you, it may be of great advantage to your company to have Pollak do it. Certainly it is good business to at least learn in detail what Pollak has to offer you. We will be glad to put the complete story before your executives.

POLLAK PRECISION PRODUCTS

The original Army-Navy "E" award to this company has been renewed four times. Each of the four stars on this flag symbolizes six months of exacting service to our Armed Forces.

POLLAK MANUFACTURING COMPANY · ARLINGTON, NEW JERSEY

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From the Industry

Principles Suggested for an American Air-Power Policy

Suggestions have been made for the establishment of an American policy with regard to air power, based on the following principle: The United States should maintain an air power sufficient (in conjunction with other forces) not only to win this war but also to keep the peace: (1) by maintaining adequate air forces at such strength and in such state of readiness as to preclude a successful assault upon our country or its possessions; (2) by acquiring and maintaining air bases essential to our security and that of overseas trade; (3) by facilitating the orderly and economic expansion of domestic and international air transport and of private flying; and (4) by preserving a strong aircraft-manufacturing industry.

The report reviews the history of the development of American air power from a time before the first World War and emphasizes the services of the Morrow Board and of the leaders of the aeronautical industry. It is brought up to date by a survey of the current situation.

The recommendations and an estimate of the future are summarized as follows: The record to date clearly shows the wisdom of having depended entirely upon private industry for aircraft production. Industry has met every requirement as to quantity and quality. The stimulus of private competition has produced great benefits. Technology has advanced. Costs have been reduced. The whole management of aircraft production in this war under the principles enunciated in the Morrow Report has been so successful as to indicate clearly the wisdom of continuing these policies. In fact, the whole relationship of Government and industry in the aircraft program sets a sound pattern for other lines for the future.

International, domestic, and private air transport offer a source of new wealth and employment. Rapid development is dependent upon improved technology stemming from a strong competitive private manufacturing industry. A dominant military and naval air force supported by air bases is a prerequisite of free communication by land, sea, and air. Only air-minded people can provide that controlling air power which is the hope of lasting peace and prosperity. The Aeronautical Chamber of Commerce of America, Inc.

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Engineering Review.

Aircraft Electrical Council Formed

To provide a more effective contact between the aircraft and the electrical manufacturing industries, the Aircraft Electrical Council, a subdivision of the National Electrical Manufacturers Association, has been formed.

The Council, composed of member companies producing electrical equipment for use in aircraft, will make available the experience and facilities of electrical manufacturers to producers of aircraft and to those representatives of the armed forces interested in aviation problems. At the same time the Council will provide member companies with information about performance and production requirements of electrical equipment for aircraft applications and will contribute to the development of pertinent purchase specifications. The Aircraft Electrical Council of the National Electrical Manufacturers Association.

Pacific Coast Aircraft Production Statistics

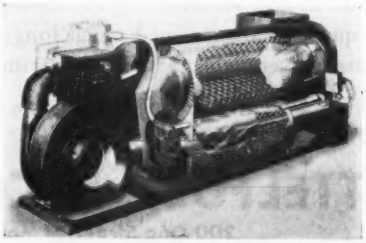
With larger and heavier warplanes in accelerated production, the 1944 first-quarter poundage output of Pacific Coast aircraft plants, excluding spare parts, was reported to be 60.7 per cent ahead of the like period last year and exceeded the first three months of 1941 by 1,337 per cent.

March delivery of air-frame weight by the companies was 36,015,200 lbs., a new high mark for a single month, and brought the first-quarter total to 100,376,200 lbs., excluding spare parts. Last year the quarter's output was 62,445,000 lbs., and in 1941, before the United States entered the war, the quarterly total was only 6,982,000 lbs.

March deliveries were 2,703 units, the best of any month to date, exceeding February's total by 134 and the January output by 144. The first quarter total of 7,831 planes was 33.8 per cent greater than the 5,853 produced in the first three months of 1943 and was 506 per cent ahead of the 1,291 built during the corresponding period of 1941.

Illustrating the growing production per individual worker, the average output of air-frame weight rose 514 per cent in 3 years, from an annual rate per employee of 226.68 lbs. in January, 1941, to 1,392.36 lbs. annually per employee at the beginning of this year.

The figures are for the Pacific Coast plants of seven companies—Boeing, Consolidated Vultee, Douglas, Lockheed, Northrop, North American, and Ryan. Aircraft War Production Council, Inc.



The Anchor Post Fence Company's combustion-type aircraft heater.

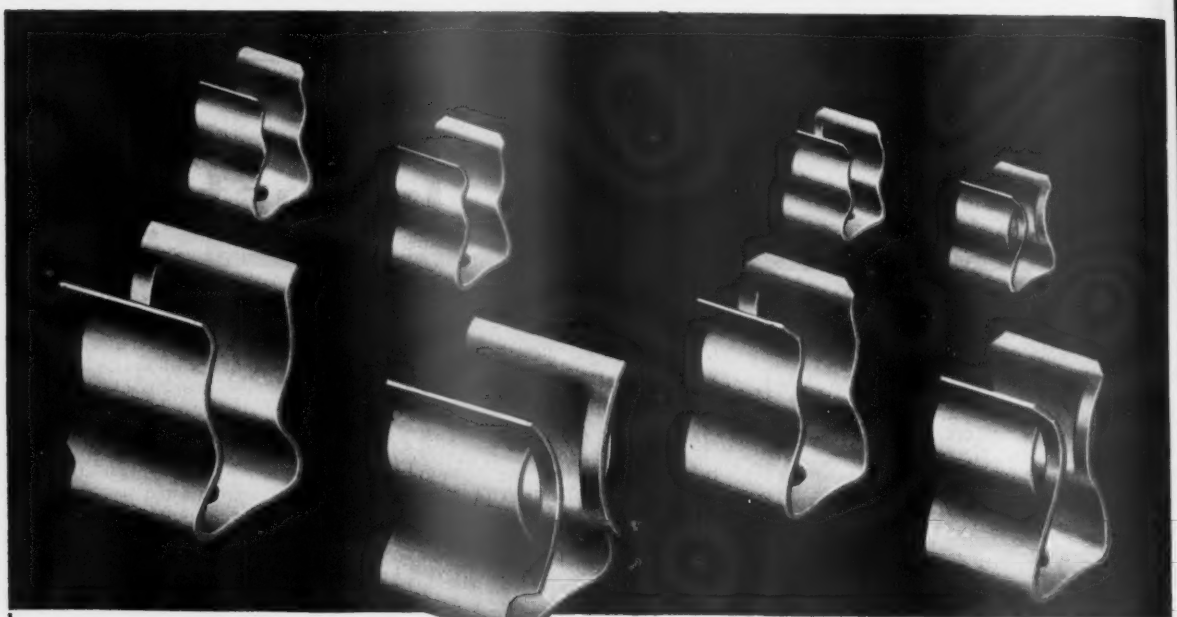
Aircraft Heater

An aircraft heater of the combustion type, burning gasoline from the plane's tanks, is in use on Navy patrol bombers and other airplanes. It combines the multiple functions of cabin heating in flight and not in flight with the transfer from one phase to the other automatically controlled. It defrosts the pilot's windshield and bombardier's window, in addition to preheating the engines for quicker take-offs in arctic temperatures.

In tests it is reported to have functioned properly at temperatures as low as −72°F. and at altitudes up to 40,000 ft. It uses about the same amount of electric power as the average reading lamp. In flight the heater has an hourly output of 90,000 B.t.u. Anchor Post Fence Company, Baltimore.

Apex Washing Machine Motor Serving War Effort

Electric motors made to power washing machines are now used to operate equipment for testing supercharging pumps for aircraft. The pumps, used with Pratt & Whitney 18-cylinder radial aircraft engines, are designed especially



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ESPECIALLY ENGINEERED TO THE MULTITUDE OF TODAY'S SERVICES

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Wherever fuse clips are used—in aircraft, communications, industry, electronics, electrical products—from most delicate meters to high voltage services, Littelfuse solves the problems with *new improvements.* By exclusive Littelfuse design and forming, the best possible contact is obtained, with maximum electrical conduction. Less heat is produced. Temperatures in panel boards and switches are reduced. Loss of clip-temper is prevented. Spring qualities are retained much longer. Contact between fuse cap and clip is made over *largest possible area* with extra tight grip.

Whatever your fuse clip requirements, Littelfuse will be glad to counsel with you.

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for high-altitude flying. Because of the severe strains placed on them in such service, they are subjected to strenuous test runs before shipment.

To simulate actual flying conditions the pumps are placed in a housing that corresponds to their position in the frames of the aircraft engines. Then, powered by the 1/4-hp. Apex washing-machine motors, they rotate on a vertical shaft at 1,200 r.p.m. The pumps and housings are both sealed to prevent air leakage. Rigid pressure and temperature restrictions are maintained for the 8-hour test run. Apex Electrical Manufacturing Company, Sandusky, O.

Two-Piece Grommets

The Dura-Grom is offered as a fume- and watertight, vibration-proof grommet for supporting lines through a fire wall or bulkhead. It consists of only two parts: an oil- and gasoline-resistant synthetic-rubber disc and a plated steel retainer for securely attaching the grommet to the wall. A complete tube assembly may be slipped through the fire wall and Dura-Grom retainer and permanently fastened at the ends. The split synthetic-rubber disc is then easily installed by slipping it over the line, sliding the retainer in place, and bolting it to the fire wall, completing the installation. Three standard sizes of cup retainers are available, and each can be furnished with rubber discs to fit six different sizes of tubing. Arens Controls, Inc., Chicago.

Sealing Compound for Porous Castings

For impregnating magnesium, aluminum, and other metal castings tending to be porous, a synthetic resin has been developed specifically for use with monomeric styrene. This new resin is a 100 per cent nonvolatile compound, having a viscosity of Y–Z on the Gardener-Holdt scale (18–23 poises).

The usual mixing proportion is equal parts of resin and styrene, although this depends somewhat on the porosity of the casting. An equal-parts mixture gives a viscosity of approximately 35 centipoises. If the casting capillary openings are small, more styrene is used in the mixture, raising it to about 40 parts of resin to 60 parts styrene. If they are large, the viscosity is increased by using a mixture of 60 parts resin to 40 parts styrene.

It is claimed that this new resin has the property of cross-linking with the styrene molecule during polymerization without the aid of any catalyst. In fact, the impregnating solution is simply prepared by mixing the desired proportion of resin and stabilized monomeric styrene. Because of the cross-linkage between the two molecules, the copolymer is gasoline-insoluble.

The recommended impregnating procedure for sealing porous castings is the usual vacuum-pressure method, where the vacuum removes the air from the casting and the compound is forced in under pressure. Variations may be made in this technique to meet certain specialized conditions. After the casting has been impregnated, it is baked 2 hours at 250° to 275°F. to polymerize the sealing compound. It is desirable to bake the casting under pressure. Because no volatile solvents escape when baked under pressure, the sealing is efficient and it is rare that the castings have to be rerun a second time for a complete seal.

The usual industrial cleaners work satisfactorily to remove the synthetic resin-styrene solution from the outside of the castings after impregnating and before baking the sealing compound. It is believed that this resin, when used with monomeric styrene, will find a use in many fields other than the foundry industry. It is identified as Ault & Wiborg No. 988 Magnesium Sealing Compound-Styrene Soluble. A bulletin is available giving full information about the compound. Ault and Wiborg Division of Interchemical Corporation, Cincinnati.

Hydraulic Shut-Off Valve

The KwiKloz hydraulic shutoff valve is a single-seated, balanced shutoff valve that is not affected by back pressure either in open or closed position. It closes instantaneously against a maximum pressure of 1,500 lbs. per sq.in. and is capable of operation at extremely low temperatures. Designed for hydraulic testing systems and aircraft hydraulic-system lines, the valve has a stainless-steel shaft, valve stem, and spring. It is interchangeable in the field to permit quick replacement in operation.

It can be quickly changed for either clockwise or counterclockwise operation as required. Made of corrosion-resistant parts, heat-treated, ground, and polished, the valve will be available for a variety of needs. Automatic Products Company, Aircraft Division, Milwaukee.

Bell Helicopters

Information has been released concerning the development of a new Bell helicopter incorporating principles for stability in flight and for precision control. These helicopters have been flying experimentally for more than a year. Developed for its expected military value as part of the manufacturer's overall war program, the helicopter is also expected to have important peacetime uses. It is one of the products that Bell expects to manufacture for both commercial and private use after the war. At present, however, the emphasis is on the potential military uses involved, and no work will be done on postwar models until the war is ended.

A feature of this helicopter design is the stabilizing system. The rotor is rendered independent of the mast by the stabilizing device and tends to remain in a horizontal plane. This stability is expected to give increased simplification of controls when such craft can be made available for the general public.

The two-bladed rotor used on these helicopters also makes possible a simplified hub design. The Bell machine uses a conventional antitorque propeller on the tail and has a three-wheel landing gear. The Franklin engine, rated at 160 hp., is of the horizontally opposed air-cooled type and is mounted vertically directly aft of the pilot's compartment.

Rotor, mast, transmission, and engine are mounted integrally and are set in the fuselage in soft rubber mounts in order to reduce vibration. The span of the rotor is 33 ft. and the diameter of the antitorque propeller is about 5 ft. The main rotor blades are of solid wood construction, with a steel insert in the leading edge to aid in mass balancing and for added strength. The antitorque propeller is two-bladed, variable pitch, also with solid wood blades. It is driven by a tubular shaft and is controlled by a cable and pulleys.

The main rotor of the Bell machine is free wheeling, as on conventional-type helicopters. When the engine stops, the blades run free in autorotation. The machine uses cyclic pitch control to compensate for varying degrees of lift on the leading and trailing blades.

In the cabin the pilot and passenger sit side by side, with an automobile-type door on either side of the enclosure. The pilot's controls include a stick that controls the horizontal direction of flight and the throttle and a left-hand lever that controls both the rate of ascent and descent and the orientation of the ship around its own axis. Bell Aircraft Corporation.

Spitfire Mark XII

The Spitfire Mark XII was designed for exceptional performance at low altitudes. It was realized even prior to the Battle of Britain that performance at low altitudes might well become one of the deciding factors of the air war. So to supplement the high-altitude fighters already being built, Supermarine began the design of an improved single-seater fighter to be powered by a Rolls-Royce Griffon engine.

In developing the new fighter, some acute problems of design had been solved. The substantially increased size and weight of the new engine in comparison with the Merin necessitated modifications to many sections of the aircraft. A new fuselage, reinforced and strengthened to support the heavier engine, was designed, and an entirely new type of engine mounting was introduced. The prototype, first flown in 1941, was fitted with standard-type Spitfire wings, but it was soon evident that still further improvements should be made. Clipped wings were substituted for the standard type, and an improved rudder was another addition, giving maximum maneuverability to the Mark XII.

The lines of the cowling were also modified, giving a greatly improved aerodynamic form, and the fixed tail wheel was replaced by the latest retractable type. In full operation by the Royal Air Force, the new improved maneuverability and increased speed and rate of climb at low altitudes com-

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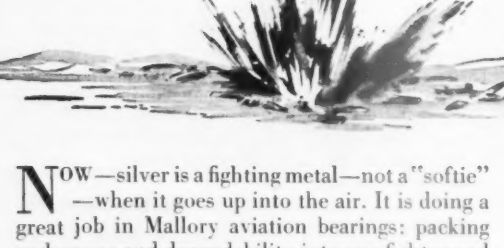
NOW—silver is a fighting metal—not a "softie"—when it goes up into the air. It is doing a great job in Mallory aviation bearings: packing endurance and dependability into our fighter and bomber planes.

Through the Mallosil* process of bonding dissimilar metals, Mallory silver-bonded bearings, rocker arm bushings, pinion races and other vital engine parts are meeting incredible stresses and strains encountered in seven-mile-a-minute speeds, breathless dives, and hair-raising maneuvers.



Mallory has developed the silver-bonded bearing to precision quality with a hitherto unknown uniformity and dependability. This permits volume production of bearings with the narrowest tolerances ever called for—and with virtually no variations. It is the reason why aviation engine manufacturers have come to depend upon Mallory as the reliable source of supply.

Obviously such wartime developments mean much to future commercial aviation. But progress does not stop here. Wherever heavy duty bearings are used, Mallory bearings have a gain to offer to design engineers because of their ability to take high peak loads.

Although Mallory production is concentrated on the war effort, we are ready to cooperate in planning for the future. Mallory engineers will be glad to discuss your problems with you.

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bined to produce a machine with a much better combat performance. British Information Services, New York.

New Electrical Connector

The type AN 3101 electrical connector is made according to the proposed AN-W-C-591a specifications. Although in general appearance this new type looks like a plug, it has been designated as a "receptacle" inasmuch as it has a male coupling thread similar to types AN 3100 and AN 3102.

It is a mating-cord connector for AN 3106 and AN 3108. Since it has no mounting facilities such as the flange on types AN 3100 and AN 3102, it may be used in place of an AN 3100 or AN 3102 when regular mounting is not necessary. It is also adaptable for use with an extension cord. Cannon Electric Development Company, Los Angeles.

Set of Adjustable Hole Cutters

Three adjustable hole cutters that cut all diameters from $^5/_8$ in. to $3^1/_2$ in. are furnished in sets either with straight shanks for use as hand tools in portable electric and pneumatic drills or in light drill presses. They are claimed by the manufacturer to produce accurate, clean holes that require no after-grinding, reaming, or filing. The cutters are adjustable and can easily be sharpened by any competent mechanic. They may also be used in lathes and other spindle-type machines.

The cutters consist of a straight shank on a hexagon body into which are set three high-speed steel blades at 120° intervals. In addition to their adjustability, these tools are designed to cut holes in varying thicknesses of materials. For example, the largest of the three tools has a capacity ranging from thin sheets to $^5/_8$ in. thick ($1^1/_4$ in. where work can be reversed). It is claimed that the balance provided by the special three-blade design makes it possible to cut holes in curved or irregular surfaces such as pipe or tubing. The cutters work in aluminum, dural, steel, brass, wood, plastics, fiberboard, and many "problem" materials.

Shanks are heat-treated and the three blades are of precision-ground, high-speed steel. The smallest of the three cutters has a $^3/_8$-in. straight shank, cuts holes $^5/_8$ to $1^1/_4$ in. in diameter, and is equipped with a $^1/_4$-in. drill pilot. The second size has a $^1/_2$-in. straight shank and cuts all diameters of holes between 1 and $2^1/_2$ in. The largest hole cutter in the set has a $^1/_2$-in. straight shank or No. 2 Morse paper and operates at all diameters between 2 and $3^1/_2$ in. The hardened and ground pilots on the larger-sized tools are removable and may be replaced with lead drills if desired. Robert H. Clark Company, Beverly Hills, Calif.

Aircraft Smoke Detectors

Fire in the cargo space of an airplane can now be discovered automatically by means of a smoke detector developed by research engineers. Any trace of smoke in the cargo space causes the detector to warn the pilot by lighting a red lamp on the instrument panel and sounding an alarm. If the space is protected by a built-in carbon-dioxide fire-extinguishing system, the pilot simply pulls a lever on the instrument panel and the space is immediately filled with gas.

The C-O-Two Aircraft Smoke Detector has a small and lightweight cabinet into which air is constantly forced by a blower or by an exhauster that makes use of the air currents caused by the flight of the plane. Smoke particles in the air stream automatically actuate the mechanism that sounds the alarm and lights the red lamp.

After the fire is detected, the alarm is silenced by resetting a switch. The new device is a development of the manufacturer's marine smoke-detection systems, which have been in use for many years. C-O-Two Fire Equipment Company, Newark, N.J.

Convair Model 39 Commercial Transport

Development of a 48-passenger commercial transport plane, designated as Model 39, has been announced.

Designed to replace the standard air liners of today on routes both within continental limits and spanning oceans, Model 39 incorporates the wing, power plant, and landing gear of the Liberator bomber, together with a specially designed fuselage intended to provide maximum safety and operating efficiency as well as speed and passenger comfort.

The new airplane is designed for long-range operations and will carry 48 passengers with baggage and 1,200 lbs. of mail on flights up to 2,500 miles. As a sleeper plane, Model 39 will accommodate 24 passengers, and a cargo version is expected to carry a pay load of 12,000 lbs. over similar distances.

Normal cruising speed will be 240 m.p.h. contrasted with 180 m.p.h. for present-day planes. Normal gross weight will be 56,000 lbs., although the craft is designed for provisional gross weights up to 64,000 lbs.

One model of the interior combines specially designed reclining seats with a novel canted arrangement of the seating plan. Other designs provide for convertible day and night arrangements with comfortable, full-size upper and lower berths and all seats of the reclining type facing forward. Consolidated Vultee Aircraft Corporation.

Multiple Thread Taps for Aircraft Fittings

Special Acme multiple-thread taps for threading of quick-removable-type fittings as used in aircraft assemblies for fastening cowling, etc., are in production. They range from $^3/_8$ to 1 in. in diameter, both 12 and 10 pitch, and available types include a range from double to sextuple thread taps. Detroit Tap and Tool Company.

Increased Armament for the A-20

Addition of a power turret housing two 0.50-caliber machine guns increases the armament of the Douglas A-20 in the attack version to nine 0.50-caliber guns.

The turret guns may be swung in a 360° arc, with interrupter cams shutting off their fire when the guns are pointed at interfering portions of the fuselage or rudder assembly.

Six guns protrude from the nose and another is fired through the gunner's access door in the plane's underbody to protect the rear. Alternate armament, publication of which is not yet permitted, is also possible. Douglas Aircraft Company, Inc.

Magnesium Alloys in Aircraft Construction

Recent utilization of certain magnesium alloys in production changes undertaken in the Douglas C-47 airplane have proved satisfactory, according to a report by the manufacturer of the airplane.

The floor and subfloor structure of the C-47 airplane is entirely different from, and much heavier than, that of the DC-3 airplane. Since the wing structure passes through the fuselage, those floor beams located directly above the wings are not so deep as those used elsewhere in the fuselage. The smallest beam in the area above the wing is $1^1/_8$ in. in depth; the largest beam in the fuselage is 10 in. in depth. Some of these floor beams are extrusions and some are built-up Wagner-type aluminum-alloy extrusions. There are also a few aluminum-alloy extruded floor beams. The largest beams are located where the heavier cargo items are tied down to the floor. Although the extruding requirements made the webs of the 6-in. magnesium-alloy beams heavier than they had to be for structural requirements (their thickness is 0.093), the magnesium beams are still 5 per cent lighter and about 25 per cent stronger than the built-up aluminum-alloy beams. The material used is the Dowmetal C-1 alloy.

The service record for all three types of beams has been entirely satisfactory. After the airplane had been in service about a year, it was found necessary to reinforce one of the built-up aluminum-alloy beams, otherwise there has been no indication of inadequate strength in the floor beams. The Dow Chemical Company.

Exhaust Heater

Hexheat is an exhaust heating unit for airplane and industrial application. It is of tube construction, intended to give uniform airflow control. Airflow can be arranged across flow, co-current flow or counterflow, whichever may be most desirable and efficient for the condition involved.

Originally designed to meet aviation needs for utilization of exhaust heat for wing deicing, cabin heating, and related purposes, this unit is adaptable to a wide variety of needs. Modifications

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can be made to meet special operating conditions and space limitations. Drayer & Hanson, Inc., Los Angeles.

Improved Explosive Rivet

An improved explosive rivet that fits itself to the hole has been developed for greater speed and uniformity of results in riveting military planes. The rivet is expanded from within along substantially its entire shank by a light explosive charge. The original rivet, introduced two years ago, was expanded at the end of the shank to lock it in place. Improvement of the rivet, made of aluminum alloy, was accomplished by embodying in it a small auxiliary explosive cavity and modifying slightly the explosive charge. The auxiliary cavity extends from the main chamber in the shank toward the head of the rivet. Detonation of the charge expands virtually the entire shank, so that an exact fit between the drilled hole and the shank is no longer required.

The new rivets will be available in diameters of 5/32 and 3/16 in. in the modified brazier types and possibly in other types. The explosive charge is usually detonated by an electric riveting iron that fires the charge in the cavity when the heat is applied to the head. The new explosive used has the same noncorrosive, nontoxic and high-stability properties as the explosive in the older type. The same tools can be used for installing both types. E. I. du Pont de Nemours & Company, Inc.

New Wildcat Fighter

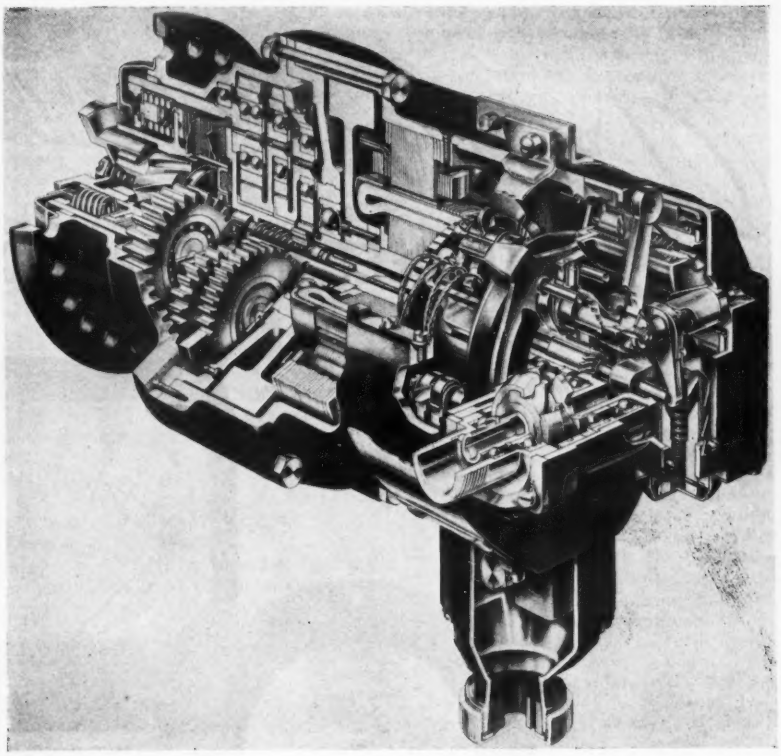
A new version of the Wildcat carrier-based fighter has been designated the FM-2. According to operational reports, it can climb faster than its predecessor, and other improvements include a considerably shorter take-off and lower landing speed. This new model Wildcat is powered by a hitherto unannounced Wright engine, with a number of new features including forged cylinder heads. Despite a sizable increase in power over the engine previously used, the weight has been decreased.

The FM-2 is reported to be in active service with several of the aircraft carriers of the U.S. Navy. Eastern Aircraft Division, General Motors Corporation.

Three Socket Wrenches Combined in One

Having the same approximate dimensions as a single socket wrench and with little additional weight, the Tesco multisocket wrench accommodates No. 10 standard, No. 12 standard, 1/4-in. standard and light, and 5/16-in. light hexagon nuts. By pressing the wrench over any of the three sizes of nuts, the operator selects the proper nested hexagonal tube suited to that particular nut.

The wrench is specifically designed for heavy-duty service, for factory production, or for servicing work of any kind. Its design is such that any stress incident to turning a nut is transferred to the outer hardened-steel casing. It is also designed to provide a clearance through the barrel for studs up to 5 1/2-in. length. Both handle and barrel have molded insulation capable of withstanding a dielectric test for 1 min. at 5,000 volts root-mean-square. The handle is a die-cast aluminum member pressure-molded to the hexagon steel barrel. The Eastern Specialty Company, Philadelphia.



The Eclipse Series 48 aircraft-engine starter. This starter provides an initial cranking speed of 150 r.p.m. followed by direct cranking at 60 r.p.m.

Starter for High-Power Engines

Eclipse "Series 48" inertia and direct-cranking electric starters have been developed for high-speed cranking of engines in the 1,200- to 2,500-hp. class, with reserve power for larger engines that may become available up to 3,000 hp. They provide four methods of cranking: (1) combination inertia and direct-cranking for normal operation; (2) direct-cranking alone for warm engine starting; (3) inertia cranking alone when batteries are low; and (4) hand cranking for emergencies.

During normal operation with a nominal engine cranking torque of 400 lbs. ft., the starters will provide an initial cranking speed of 115 r.p.m. followed by direct-cranking of 60 r.p.m. They are available for one-wire, 24-volt d.c. operation, for either clockwise or counterclockwise rotation, with three- or twelve-tooth jaws. The high-speed, heavy-duty electric motor accelerates the flywheel to its normal operating speed of 24,000 r.p.m., storing nearly 16,000 ft.lbs. of energy, and provides for direct-cranking after the flywheel energy has been spent.

The starter incorporates a built-in meshing solenoid for automatic control of starter-jaw engagement and a preset friction disc overload clutch, sealed against entrance of engine oil, to protect the starter from undue loading or engine backfire. It is of concentric design, weighing 42 1/2 lbs. with a 6-in. mounting flange and 43 1/2 lbs. with a 7-in. mounting flange. It measures 6 5/8 in. in diameter and 12 5/8 in. from the mounting flange to the back head. Eclipse-Pioneer Division, Bendix Aviation Corporation.

Fluid Metering Pump Systems for Anti-Icing and Unit Heaters

Eclipse Fluid Metering Systems, consisting of metering pumps, filters, check and pressure valves, and controls, are designed to provide a metered flow of fluid required for anti-icing of propellers, carburetors, windshields and aircraft unit heaters. Type 1415 will provide 2 to 9 gal. per hour per outlet, while type 744 will deliver 0.5 to 3 gal. per hour per outlet. They operate from 24-volt d.c. power supply. Control of motor speed to vary the flow is obtained either by a variable control or by fixed or adjustable resistance.

Pumping-head parts, lapped to close tolerances, are designed to assure dry prime regardless of pump location and to provide intermittent pressures of 350 lbs. per sq.in. or more to overcome temporary restrictions. Vapor forma-

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tion and cavitation at altitude are minimized by the positive-displacement, low-speed, motor-driven, gear-type pump designed with integral worm and wheel reduction. Stainless-steel alloys are used exclusively in the pump head to eliminate the possibility of corrosion.

Explosion-proof electric motors incorporate sealed, prelubricated ball bearings and are designed with a large torque reserve to permit starting and continued pump operation under extreme cold.

The fluid filter prevents foreign matter entering the system from the reservoir, eliminating restrictions from that source, and the fluid-pressure and check valve maintain correct pressure in aircraft unit-heater systems, returning excess fluid to the reservoir. Eclipse-Pioneer Division, Bendix Aviation Corporation.

Arc-Welded Boom for Airfield Service Tractor

A crane boom mounted on a caterpillar tractor—designed and constructed for lifting engines, propeller assemblies, tail ends of planes, and other general hoisting operations—has been developed at an Army airfield by means of arc welding.

The boom is constructed of 1- and 2-in. aircraft tubing with a $^1/_4$-in. wall thickness and is completely arc-welded. The base is slotted and reinforced with 1-in. bolts holding it to two uprights made of armor plating set in back of the bumper of the tractor. The boom was designed for lifting 10 tons, but, when attached to the 5-ton tractor for portability, it is necessary to design a wheel assembly that acts as a fulcrum and holds the tractor on an even keel when hauling excessive loads around the airfield.

The hook on the boom is made of six-sided bar stock and tempered just enough to bend at severe strain. Channel iron and sheet steel are used for the sheave, reinforced with bosses in each section to prevent buckling. The cable holding the boom is $^3/_4$-in. flexible cable with a snapping point of 23.6 tons.

The supporting wheel assembly was designed to be retractable so that the tractor could move the weight on the boom and deposit it with the least effort. In the down position there is a clearance of only $^3/_4$ in. above the ground, little tilt being allowed. The wheel assembly is raised when the boom is idle and, if the tractor is out servicing planes, it is not in the way when the tractor is traveling at a fast speed over rough ground. The Hobart Brothers Company, Troy, O.

Seam-Welding Control

A control designed exclusively for seam-welding and incorporating a completely electronic timing circuit is designated as Type CR7503-B110. The new resistance-welding control is especially suitable for operations where frequent changes of the timing pattern are required, such as when welding a variety of materials of various shapes and thicknesses.

Operating on a 230/460/575-volt, single-phase, 60-cycle power supply, the control consists of a timing panel, a firing and a heat control panel, and a power panel, any one of which can be separately disconnected and removed to facilitate inspection or servicing. An electronic circuit, incorporated in the control, provides accuracy of the timing pattern of the weld without utilizing moving parts and regardless of normal, instantaneous, or gradual line-voltage variation. Smooth heat control is provided by the phase-shift method.

The complete control is mounted in a floor-type enclosure. A calibrated heat-control dial is located on a panel readily accessible through a flap opening in the front door of the enclosure. Snap switches for providing adjustment of the "heat" and "cool" time in one-cycle steps from one to 30 cycles also are located on this panel.

All tubes and connection terminals are conveniently located, the water supply inlet and outlet fittings are on the outside of the enclosure, and a row of indicating lights on the front door show whether (1) the water flow is adequate, (2) power has been applied, and (3) the time-delay has timed out. General Electric Company.

Portable Oil Filter

For filtering aircraft-engine lubricating oil a portable model AF-1400 filter has been developed. The complete unit consists of a gasoline engine-driven rotary pump, which draws oil from the engine through a suction hose attached to the oil-supply tank. Oil is circulated through six full-flow filters, mounted in series and parallel. A metal box houses two 20-ft. lengths of oil-resisting hose. The complete assembly fits in the rear space of an army jeep.

As soon as possible after a plane lands and while the oil is still warm, the unit is driven out to the plane. The suction hose is attached to the oil-supply tank and the discharge hose to the filler cap of the tank. The engine of the filter unit is then started; 25 to 30 gal. of oil are purified per minute, while other servicing operations are being performed. A more thorough cleansing job is accomplished if the engine of the plane is left idling during the process. The time required per engine is 10 to 15 min.

Filtration is claimed to be positive to a fineness of 5 microns. Each filter cartridge has an area of 1,000 sq.in. and can be cleaned several times in gasoline or kerosene. Two pressure gauges, one on the inlet and one on the outlet side of the filters, indicate when filter cartridges should be cleaned or changed. The filters are full flow, with a by-pass valve that opens at 15 lbs. General Filters, Inc., Detroit.

Battery Hold-Down Clamp

A patented battery hold-down clamp is designed to alleviate the difficulties encountered in removing or changing batteries under extreme climatic conditions or where timesaving is important.

The clamp replaces the two wing nuts. By the use of the clamp, in which is incorporated a cam action, all safety wiring is eliminated. The positive locking action is obtained from the pressure exerted on the cam. Distinctive features of the clamp are that it is obtainable with various nut sizes, and screws into present battery boxes. The cam lever is easily released manually. The Paul Henry Company, Los Angeles.

Gauge and Valve Assembly

The Kenyon gauge and valve assembly is designed for permanent installation in the wheel nacelle or other accessible point on a plane to take pressure readings of the air bottle for the hydraulic shock-absorber system of the landing gear.

An added feature is a valve that relieves the pressure valve and Schrader valve except at testing, while readings may be obtained when the plunger is depressed. It can also be utilized to test pressure in charging the accumulator. The weight of the assembly is 10 oz., gauge diameter is 2 in., and overall diameter is 3 in. over the lugs. The pressure range is from 0 to 3,000 lbs. Kenyon Instrument Company, Inc., Huntington, N.Y.

Freedom of Air Trade

In the development of air transport between the two wars Great Britain suffered, on a number of occasions and at the hands of a number of different states, serious interference with, and dislocation of, her plans. In some cases it was a refusal of the freedom of air passage; in others, and more frequently, it was a denial of air facilities. Sometimes the desire to engage in air trade—to pick up and set down passengers and goods in their territories—was refused by foreign countries.

The right of a state to control, in accordance with its own interest and policy, air trading within its frontiers is not normally disputed, but international public opinion is becoming increasingly critical of national restraints with regard to the freedoms of both air passage and air facilities. Indeed the governments of the United Kingdom and the United States have recently made declarations favoring freedom of air passage and freedom of air facilities throughout the world.

It would, however, be the gravest misconception to assume that this question of the freedom of the air is thus virtually settled. Even with free air passage and free air facilities one state could still hold other countries to ransom with regard to air trade. Setting aside the whole question of cabotage—the carriage of passengers and goods between two points within a foreign state—a government could cause serious international friction if this right of controlling air trade were abused. To cite only two examples: it could refuse permission to a foreign air line flying through its territory to set down passengers from

abroad or vice versa. Involving even graver political issues, it could, in return for payment or some other consideration, grant rights of air trade to one country and withhold them from others.

Thus, it would be the height of folly for any government to commit itself to a policy of free air passage and free air facilities until this more complex and more vital question of the international organization of air trade and commerce has been squarely faced and the problems solved.

British trade and industry are in favor of as wide a measure of freedom being enjoyed by international air transport as conditions in the early postwar period may permit. They are, however, strongly opposed to any suggestion of unilateral economic disarmament by which the British Empire would throw open its world-wide system of airports to foreign air liners without appropriate guarantees. Of these a foremost requirement must be the granting to Britain of most-favored-nation treatment with regard to air trade and commerce by all states using British airports, together with an obligation upon such states not to enter into any engagement with a third state by which preferential advantages would accrue to them. It is important that public opinion be seized of the dangers that might flow from any facile solution of a problem that vitally affects British export trade. The Joint Air Transport Committee of The Association of British Chambers of Commerce, The Federation of British Industries, and The London Chamber of Commerce.

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Portable D.C. Power Supply

A portable d.c. power supply is designed for use on assembly lines, in laboratories, and maintenance departments, for manufacturing, testing, and operating all electrical and electronic equipment in aircraft and other units employing 12- or 24-volt systems. The power supply can also be used to tapercharge batteries or battery carts of similar voltages.

The unit is designed to operate from three-phase a.c. lines of 208 and 230 volts. Three models are offered: No. VA1500, with output of 10 to 16 volts at 100 amp. or 20 to 32 volts at 50 amp.; No. VA3000, with output of 10 to 16 volts at 200 amp. or 20 to 32 volts at 100 amp.; No. VA4500, with output of 10 to 16 volts at 300 amp or 20 to 32 volts at 150 amp. Models with similar output but for operation on 460 volts are also available. P. R. Mallory & Company, Inc., Indianapolis.

New Base for Large Flying Boats

A new flying-boat base, designed to speed testing and delivery of PBM Mariner and JRM Mars flying boats, is being rushed to completion at Baltimore and will be placed in operation shortly. Located on Strawberry Point adjacent to the Martin Airport, to which it will be connected by a concrete taxiway, the new base will be fully equipped to handle the inspection, packing, testing, operating, and servicing of the flying boats and will relieve much of the congestion on the present seaplane ramp in the manufacturing area.

Physical facilities of the new base will include a permanent, steel-constructed, daylight hangar; a two-story building to provide office and storage space; a concrete ramp, concrete apron, and concrete compass compensating area; and docks for service boats. The hangar will have a 200-ft. clear entrance with doors at either end and will be capable of holding six PBM or three JRM flying boats. Many additional boats can be accommodated on the large concrete apron.

Whereas at present all operations from preliminary ground test to packing and delivery of the PBM-3 Mariner are carried out on the ramp and apron in and around the manufacturing area, as soon as the new facility is ready many of these operations will be transferred to Strawberry Point, permitting separation of manufacturing and flying operations.

Under present plans for the utilization of the new base, all operations on the PBM Mariner prior to the Company Flight stage will be continued at the manufacturing area ramp and apron. Upon completion of Company Flight, the airplane will be taken to the new Strawberry Point ramp, where it will be beached for after-flight check, packed, inspected, inventoried by company and Navy representatives, and turned over to the Navy for delivery.

The Strawberry Point facilities will be even more fully utilized for the JRM Mars flying boats, the first of which is expected to come off the production line early in 1945. These 70-ton craft will be ground-tested in the manufacturing area and then towed to the new facility for all further preflight, flight, and delivery operations. The Glenn L. Martin Company.

Droppable Sponson Auxiliary Fuel Tank

The development of a new droppable sponson fuel tank has been announced. This tank can be used to increase the range of the PBM-3 Mariner by 60 per cent, with no appreciable effect on performance characteristics other than a 2 per cent reduction in top speed. It is easily adaptable to all types of flying boats.

The new Martin device, which is attached externally along the chines in the vicinity of the main step, overcomes one of the principal limiting factors of former auxiliary gasoline tanks by providing added planing area to compensate for the weight of the additional fuel.

For many years engineers have realized that flying boats were capable of sustaining far greater loads in the air than they are able to lift off the water. While various types of auxiliary fuel tanks were devised, none overcame this basic obstacle of water performance. With the Pierson sponson tank, however, the added planing area provided by the bottoms of the tanks compensates for the increased load to such an extent that take-off characteristics for a given airplane remain about the same as they would be without the sponsons and the added load they carry. Translated into terms of operating efficiency, this means added range or pay load at an almost negligible sacrifice of speed.

What sacrifice in speed there is need not even prevail for the duration of the flight, since these tanks are droppable and can be jettisoned as soon as the fuel they contain is consumed, allowing the airplane to continue the balance of the flight at its highest operating efficiency. This jettison feature likewise permits either one or both tanks to be dropped in case of an engine failure or some other emergency that makes a reduction in weight desirable.

For the PBM-3 Mariner there are two sponson tanks, one at either side of the hull. The tanks are designed in three sections to facilitate handling and attachment, although an additional number of sections could be used for larger airplanes. The forward sections are attached to the sides of the hull at the point where the beaching gear is normally affixed, with the remaining sections extending back to a point somewhat aft of the main step. The tanks are so designed that the bottoms of the tanks conform to the bottom of the hull and form an extension of the planing area. They are attached to the sides of the hull mechanically and can be jetti-

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soned either mechanically or by means of a gas-bottle release mechanism.

A further advantage offered by the sectional design of these sponson tanks is that it permits the aft and center sections to be attached and fueled while the airplane is up on its beaching gear on dry land, eliminating the difficulty of attaching and fueling in the water for all but the forward sections.

As yet, actual testing of the new Pierson tanks has been confined to towing-basin models. Whether or not they will be placed in production for wartime use will depend upon the tactical requirements or the various combat theaters to which PBM's are assigned. However, regardless of whether or not this development proves of immediate military value, Martin engineers are convinced that it will play an important part in postwar commercial operations, since it will not only permit a greatly increased operational range without sacrifice of pay load but can also be used to allow greater pay loads over shorter distances by the expedient of transferring part of the fuel load now carried inside the hull to the sponson tanks. The Glenn L. Martin Company.

Trimetric Projection

Four new drawing instruments and a mechanical drafting device are expected to make a new type of drawing available to engineers, architects, assembly plants, installation mechanics, and advertising and commercial illustrators.

This new type of drawing is known as trimetric projection. It is a form of three-dimensional drawing that presents an object with a minimum of distortion, making a complicated part easily understandable to the installation mechanic. While the existence of this type of projection has been a matter of common knowledge for many years, the cost of producing trimetric drawings has restricted their use to a few highly specialized operations. Now, however, by means of the new devices, these restrictions have been removed.

The mechanical drafting device is known as the Martin Axonograph. It consists of a photographic device for transforming an ordinary orthographic projection (the conventional blueprint) into a scale axonometric projection, the first and biggest step in producing a trimetric drawing. The machine is made up of a moving copy board that holds the drawing to be photographed and is adjustable in its angle of slant; an electric motor to move the board forward and back; a camera for recording the axonometric projection; a funnel with a narrow slot at the end which moves vertically and restricts the camera's view to a minute section of the drawing being photographed; a 3,000-watt light tube to illuminate the drawing; a stand that supports the rolling fulcrum of the funnel; and a movable stand that supports the camera.

In use the positioning of the print, copy board, and camera is fixed according to predetermined scales. The camera lens is then opened and the machine set in motion. The axonometric print is recorded on the camera negative mechanically, and the negative or paper print is developed as a normal photograph. Thus, the Axonograph not only reduces the time required to produce the axonometric print but permits this work to be done to an accuracy of four decimal points by a semiskilled operator instead of the trained draftsman formerly required.

After the axonometric prints are made, they are returned to the drafting room where they are positioned in their proper place in the trimetric drawing and traced. All that remains for the draftsman to do is to fill in the other two dimensions and any parts of the drawing for which prints have not been made. Even this part of the job has been greatly simplified by the four new drawing instruments: a trimetric scale with its three faces calibrated to correspond with the three axes of the trimetric drawing; an ellipse template; an ellipse underlay; and a trimetric protractor.

The regular draftsman's scale is replaced by the first of these instruments. The ellipse template and ellipse underlay together take over the duties of the compass, while the trimetric protractor corresponds to the regular protractor used for determining angles. These special instruments are used in conjunction with the regular triangles and T-square of conventional engineering drawing. The Glenn L. Martin Company.

Portable Tack Welder Speeds Bomb-Bay Door Production

The production of B-26 bomb-bay doors has been further simplified and accelerated with the introduction of a portable spot welder to tack-weld parts together in the assembly fixture. The new procedure cuts the number of operations in half and has reduced the time required to make the assembly by more than 50 per cent.

The portable spot welder consists of a spot-weld machine and transformer, counter-balanced on a small beam pivoting from an overhead trolley traveling along a 50-ft. beam. The trolley is driven by a sprocket and chain powered by a $\frac{1}{3}$-hp. electric motor. A 200-kva. machine with a welding capacity of two thicknesses of 0.040 aluminum is used, and the arrangement permits it to operate over a large floor area, with spacers provided on the I-beam to support the drive chain when the apparatus moves from the end of the beam.

Under the new procedure the skin, frames, and stiffeners for the doors are all cleaned for spot welding and assembled in a fixture. They are then tack-welded together by the portable spot welder, and the entire assembly is carried to a floor-type spot welder for completion of the welding.

Before the introduction of the portable spot welder, it was necessary first to assemble the parts in a drill fixture where holes were drilled for skin clamps; then disassemble, clean, and burr them for spot welding; put them together, fasten them with the skin clamps, and spot-weld them; and, finally, remove the skin clamps and drive rivets in the holes from which they were taken. The Glenn L. Martin Company.

Tail Enclosure for Converted Mariner Cargo Transports

The Advanced Bases Aviation Training Unit at Norfolk, Va., has devised a new tail enclosure for early-model Navy PBM-3 Mariner patrol bombers that are now being converted to cargo transports for use in the Pacific. The new enclosure replaces the tail turret on the combat version and is used as a navigator's station. Entrance is provided both through a top hatch and from the main compartments of the hull. The Glenn L. Martin Company.

Landing-Gear Design Problems

Several problems were overcome in developing the design of the landing gear for the B-26 Marauder. It was essential that the landing gear retract into the engine nacelles, but, if the type of nacelle gear which pivoted at the end of the strut were used, it would mean lengthening of the nacelle and consequent reduction in speed. The length of the strut, together with engineering limitations on the location of the pivot point, would necessitate such a gear retracting with and opening against the slipstream. On the other hand, if a gear could be designed that would open with the slipstream, it would mean added safety for pilot and crew, since such a gear would open with gravity even if the regular hydraulic system were shot away or damaged in combat.

The Marauder landing gear, which retracts almost straight up, solved the problem of the end pivot by doing away with it. Both the wheel end and upper end or steeple are free. When preparing to land, the steeple hooks into a downlock, firmly holding the wheels in down position. When retracted, the gear is held in flight position by an uplock hooking onto the wheel axle.

The actual gear consists of a shock strut or oleo, near the top of which is a W-strut. A pair of drag braces running parallel to, and extending forward and upward at about a 60° angle to, the oleo are attached part way down the shock strut. On retracting the gear after take-off the hydraulic system snaps the drag braces and W-strut shut, with their lower end describing an arc toward the aft end of the nacelle. The shock strut moves aft and up, bringing the wheel slightly forward and up into the wheel well.

When lowering the gear for landing, this procedure is reversed. However, the gear is so balanced that even where the hydraulic system fails or is damaged in combat, once the lock pin has been released, the force of gravity will drop the wheel and the drag of the air stream will give to it the final kick to lock it into landing position.

Another advantage of this type of landing gear is the added strength pro-

RETAINING RINGS are being more and more widely used because they are inexpensive and yet so satisfactory on many varieties of mechanisms. Broadly described, a retaining ring is an artificial shoulder or collar on a circular shaft or in a housing. The shaft is grooved, and the ring is snapped on.

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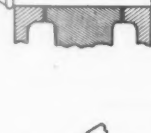

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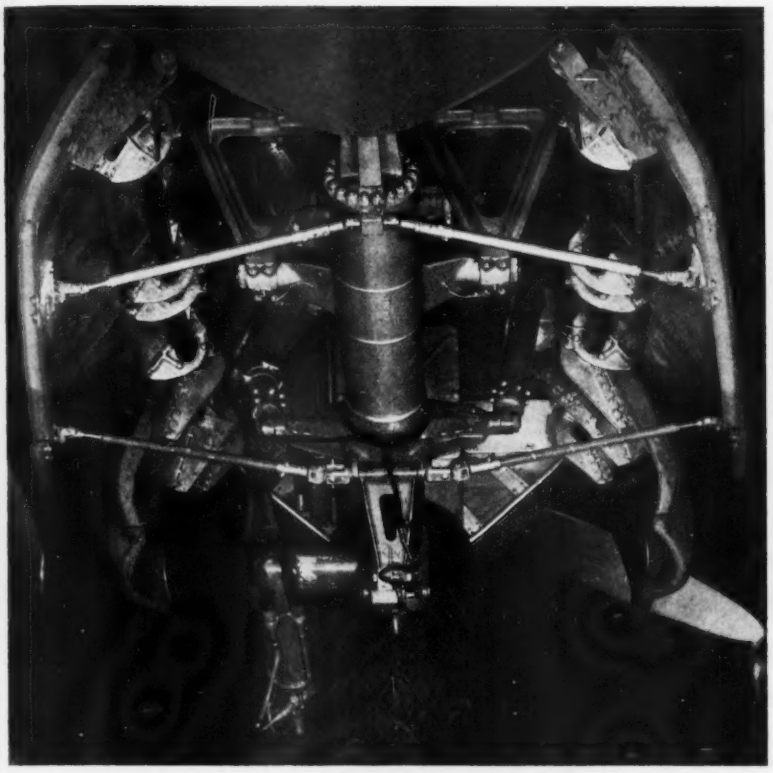


A detailed view of the Martin B-26 Marauder main landing gear as seen from the forward position. It can withstand an impact shock of over 70 tons.

vided by the two pivot points and double locking features. This is demonstrated by the fact that the same landing gear designed for the Marauder at its original 14-ton gross weight is still used, although the bomber's present gross weight is 21 tons. The Glenn L. Martin Company.

Beaching-Gear Brakes Improved

The beaching-gear brake system of the PBM-3 Mariner has been redesigned to provide greater safety for the ground crew men who handle the Navy patrol bombers. The new system permits the replacement of a vertical handle with an easily accessible horizontal lever that can be operated without danger of the operator being run down by the airplane.

Although beaching gear can be stowed aboard the Mariners, it is not actually a part of the flight equipment but rather a detachable accessory used to handle the airplane on the ground. During beaching operations, the plane is towed by a cable from a tractor, and hand brakes are used to control the movement of the airplane.

The old brake was actuated by a steel handle located between the two wheels of the beaching gear. To apply the brake it was necessary for the operator to walk directly in the path of the wheels as the airplane was being towed from the water. In the new design the brake operating lever has been moved to a horizontal position in which it protrudes over the outside wheel, placing the man out of the danger area. The change was accomplished by moving the hydraulic operating mechanism from the bottom to the top of the casting and redesigning two lugs that were bolted to the casting to accommodate the ratchet and hydraulic cylinder. The Glenn L. Martin Company.

Internal-Gear Lapping Machines

In producing certain $7^1/_2$-in. pitch diameter internal gears forming part of the gear assembly for controllable-pitch propeller hubs, Steel Products & Engineering Company, Springfield, O., is employing internal lapping to maintain desired backlash tolerances. The requirement was that these fairly large gears of $7^1/_2$-in. pitch and 250° pressure angle have a backlash of 0.001 in. when mounted in a fixture and rolled with a master gear.

To meet the requirements, these internal gears, which were shaper-finished and then hardened to 65 Rockwell, were cut in such a manner that after hardening they were, if anything, on the low side of the 0.001-in. backlash requirement. The "rejections" were then corrected by removing a small amount of stock by lapping.

The gears are lapped on a Model 996 new crossed-axis internal lapper, using 50 lbs. pressure, with a reciprocating movement of $^5/_8$ in. at a speed of 380 table cycles per min. Michigan Tool Company, Detroit.

Adjustable Switch Actuator Bracket

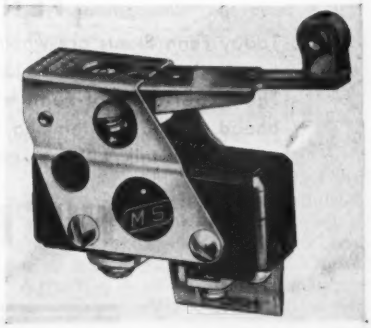
A new adjustable actuator bracket for Micro Switches permits adjustment of both the operating point and pretravel without disturbing the installation. The bracket, designated as AD-5721-R, retains the sealed-in features of the basic switch which prevent tampering with the elements that control the characteristics of the switch but provides tabs on the steel actuator bracket and the lever arm which may be bent to change the mechanical characteristics of the unit.

By bending a tab downward the lever mechanism is held nearer to the operating plunger of the switch. The more the tab is bent, the less the pretravel. The lever arm is returned to free position after each operation by the pretravel spring that rests on top of the switch unit. The operating point of the combination is lowered or raised by bending another tab up or down. The overtravel spring mechanism consists of a spring which is preloaded above the operating point of the switch unit so that it compresses only after the switch operates. The R31 Micro Switch for which this actuator was designed is easily and quickly assembled into the steel bracket. Micro Switch Corporation, Freeport, Ill.

Inventive Problems, Solutions of Which Are of Present Interest to the Armed Forces

The August, 1943, issue of the AERONAUTICAL ENGINEERING REVIEW published a list of devices and methods needed for the war effort for which suggestions and solutions were invited by the National Inventors Council. The War Department has now authorized the release of a second list of that kind comprising problems the solutions of which would be helpful in the prosecution of the war. Ideas directed toward the solution of these problems should be submitted to the National Inventors Council, Department of Commerce, Washington 25, D.C. They will be promptly analyzed and those that appear novel and promising will be placed in the hands of appropriate military personnel.

The following is the list of subjects on which suggestions are desired: (1) A relatively simple gauge to measure the impulse of explosion blast, positive and



The Micro-Switch Corporation's adjustable actuator bracket.

CORSAIR FG-1 *Built by Goodyear for the Navy*

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negative phases to be determined separately but concurrently. It would be desirable if the duration of each phase could be determined in some simple manner.

(2) A waterproofing compound for field application to nets. The compound must be susceptible of aqueous application. It must be colorless and not affect the flameproofing or infrared reflectance of the nets. It should add as little weight as possible to the fabric, should not seriously affect the "handle" (tackiness, flexibility, etc.) of the net fabrics, and should not adversely affect the tensile strength of the nets.

(3) A lightweight material, other than Neoprene, Buna S, or other similar rubber substitute now commonly used, which will hold air and CO_2. The material to be of noncritical materials and inexpensive.

(4) A light detachable rock-drill bit grinder for resharpening detachable bits. Capacity approximately 20 bits per hour and weighing 200 to 250 lbs.

(5) Removal of dissolved mineral matter from sea water and brackish water by ionic exchange process.

(6) Means of controlling fires in fighting tanks for a sufficient period of time to evacuate personnel. The process should not be injurious to personnel and should be manually controlled and operated.

(7) Waterproof compound for treatment of duck used in fabrication of canvas drinking-water storage tanks.

(8) For field use, a simple, practical, and accurate method of determining moisture content of aviator's breathing oxygen.

(9) A means for unloading ships by use of a quickly erected tramway.

(10) Means for increasing life of standard automotive or stationary engines when operated on 91-octane fuel.

(11) The use of antistripping agents with cut back asphalts to permit effective coating of wet aggregates.

(12) Additional methods for the chemical stabilization of soil.

(13) A means for removing asphalt from drums and melting to pumpable temperature on a quantity-production basis.

(14) A quick and effective nonbituminous dust palliative for all climates.

(15) Device to maintain or indicate, within 5 ft., the relation of an aerial camera to the vertical.

(16) Reduction of glare from glass surfaces by durable coatings suitable for field application.

(17) Optical method for determining the difference between an artificial green and a natural green.

(18) Destruction and removal of obstacles to landing operations. Obstacles may be visible or concealed and may be off shore or on shore.

(19) Short-base, wide-angle range finder readily portable and capable of being mounted on a vehicle.

(20) Location and destruction of concealed enemy emplacements, pillboxes, and similar strong points.

(21) Methods of protecting our vehicles from the effects of enemy land mines.

(22) Improvements in tank vision devices and control instruments. There is special interest in reducing space requirements and improving performance of gyroscopic compasses.

(23) Ingenious and simple decoy devices for the purpose of confusing and misleading the enemy.

(24) Technical data as to strategic enemy targets, such as chemical plants, explosive plants, power plants, etc.

(25) A voice-transmitting gas mask that would permit the wearer's voice to be heard with clarity.

(26) Clothing giving protection against falling pieces of white phosphorus.

(27) Colored smokes using readily available pigments for obtaining the desired color.

(28) Protective ointments to counteract vesicants.

(29) Methods of generating stable artificial fogs, and methods of dispersing artificial and natural fogs.

(30) Protection against flame throwers.

(31) Odorless toxic agents.

(32) Design of life vest that automatically inflates and turns the man on his back when he is thrown overboard by concussion and is unconscious.

(33) Noiseless hand generator combined with a lightweight flashlight. The generator should be pumped at a rate of 40 r.p.m., and the light should be continuously brilliant and start on the first pump.

(34) Plumb-bob type of generator to operate a light 6-volt radio. Generator would probably be operated by a reel winding up and letting out the plumb-bob.

(35) Methods of insuring CO_2 inflation of life rafts within 30 seconds' time at temperatures of $-20°$ to $-40°$F. The National Inventors Council, Washington 25, D.C.

Bronze-Faced Pistons for Hydraulic Struts

A new method of producing bronze-faced pistons has been released by the company that developed the process for making special pistons for Cleveland Pneumatic Aerol, Inc., division of The Cleveland Pneumatic Tool Company. The information has been restricted heretofore because the pistons were for the Aerol landing strut used on P-47 fighters.

This method involves flame-spraying of bronze on steel. Comparatively light steel blanks are sprayed with a special bronze alloy to a thickness of approximately 0.045 in. on the bearing surface. This is rough-machined in the initial production and then given the required high finish, with oil grooves, in the Aerol plant. The strut pistons were formerly machined from bronze castings, and each required about 7 lbs. of bronze. In the new process, some $3^1/_2$ lbs. of bronze are saved on each piston, and the finished product is reported to be lighter than the old pistons. One important factor claimed for the process is its oil-bearing quality. Having a fine porosity, the sprayed bronze absorbs and retains oil and becomes self-oiling after short use.

This process is now being applied to all types of pistons for compressors and pumps where the combination of strength, lightness, and wearing quality is essential. According to the producer it has been developed for the successful application of any metal to any other metal—one example being bronze and aluminum—resulting in a light, machineable, oil-bearing, and long-wearing metal. Neo Mold Company, Cleveland.

ANPT Gauges for Army-Navy Aeronautical Pipe Threads

The specifications set up by the Army and Navy for aeronautical pipe threads are stated to be met by a new line of gauges. These gauges are intended to give a rapid, accurate check on pipe threads made to the latest Army and Navy aeronautical pipe-thread specifications known as AN-GGG-P-363, Amendment No. 2, Symbol ANPT. For checking the accuracy of internal threads there is the double-end gauge, carrying the L1 and L3 thread plug gauges, which check lead, form, diameter, and taper. These are followed by a plain taper plug gauge, which checks taper, roundness, and minor diameter. The L1 and L3 plugs have three steps for classifying the thread, while the plain taper plug has six.

For checking external threads there is a set of two special ANPT Tri-Roll gauges. The first is a Tri-Roll thread gauge that checks the lead, form, taper, and pitch diameter. Three steps on the top of the gauge classify the thread. The second is a plain taper Tri-Roll gauge for checking taper and diameter of threads at crest. This has a stepped plunger and three steps on the bottom of the gauge for easily classifying the thread. A setting plug is supplied with each of these special Tri-Roll gauges. Niles-Bement-Pond Company, Pratt & Whitney Division, United Aircraft Corporation.

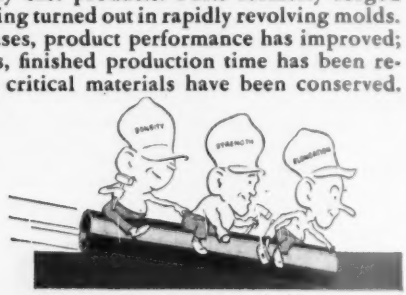
Glass-Reinforced Plastics for Aircraft Construction

Successful flight tests of an Army basic training plane equipped with a glass-reinforced plastic fuselage, side panels, and tail cone have culminated a research program initiated by the Army Air Forces Matériel Command, Wright Field, and aimed at developing high-strength plastic structural materials for use in aircraft construction.

The experimental plastic fuselage is of sandwich construction. The sandwich consists of a balsa-wood core between an inner and outer skin of plastic reinforced with fibrous glass cloth. Ground destruction tests of three fuselages of the same design—one of glass-reinforced plastic, one of metal and one of plywood—indicated that for equivalent weight the glass-sandwich fuselage is

New Uses for SHENANGO-PENN *Centrifugal Castings*

WARTIME production demands have led aviation engineers to a greater reliance upon centrifugally cast products. Parts formerly forged are now being turned out in rapidly revolving molds. In many cases, product performance has improved; in all cases, finished production time has been reduced and critical materials have been conserved.



Shenango-Penn castings can probably be used wherever wheels turn or where wearing or corrosion exist. Because the process is so flexible, it is possible to furnish flanges and to work out unusual shapes and sizes. Our standard alloys meet all Army, Navy and Air Corps specifications—and are constantly tested and checked in our own laboratory.

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considerably stronger. Firing tests have indicated that the glass-reinforced fuselage would be satisfactory under gunfire. The material did not flower and high-explosive projectiles failed to detonate because of the low density of the material.

The data revealed relate solely to experimental processes for the fabrication of glass-reinforced, low-pressure plastics in the form of laminated sheets; to the physical properties of the laminates; to experimental processes for the fabrication of the plastic fuselage, side panels, and tail cone; and to the physical properties of these aircraft parts. Further work will be required to translate these data into factory production processes.

The fuselage, side panels, and tail cone were fabricated at Wright Field. Research in the fabrication of the glass-reinforced laminates and their physical properties was conducted in the laboratories of Owens-Corning Fiberglas Corporation.

The glass reinforcements employed in fabricating the laminates were heat-treated Fiberglas cloths and short, fine fibers known as Fiberglas flock. The resins were Plaskon 900, Laminac P-4122, MR-1A, Monsanto 38691, CR-39, CR-39Bd, and CR-149. Each of various combinations of glass and resin was fabricated into 1/4- and 1/2-in.-thick laminated sheets.

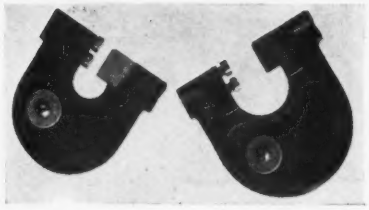
The sheets were cured at a pressure of 15 lbs. per sq.in. in an electrically heated hot-air oven. Specimens were cut from the cured sheets and were machined and tested. Test results indicated that on a strength to weight ratio, glass-cloth laminates possess physical properties comparable to those of a number of the metal alloys now used for aircraft structural parts.

Tensile strengths were found to be proportional to the amount of glass present in the laminates and varied from 43,360 to 54,720 lbs. per sq.in. Compression strengths as high as 56,820 lbs. per sq.in. were obtained; flexural values ranged between 45,350 and 84,600 lbs. per sq.in.; and impact strengths of unnotched specimens were from 28.82 to 31.25 ft.lbs. Modulus of elasticity was 2,200,000 lbs. per sq.in. Average specific gravity was 1.75. These values are for cross-laminated glass cloth. Strength values approximately twice as high may be obtained with parallel-laminated cloth. Owens-Corning Fiberglas Corporation, Newark, O.

Glass-Asbestos Textile Has Aircraft and Other Uses

Made in fabric form by combining glass and asbestos fibers, a new textile is being employed for protective gun boots and tail-wheel boots and to protect the retractable landing gear of the P-47 Thunderbolt from the hot exhaust of the supercharger.

The glass-asbestos textile is intended for applications requiring high strength combined with light weight, high abrasion resistance, and resistance to high temperatures and corrosive fumes. In textile terms, the combination glass-asbestos cloth may be classified as an inorganic canvas or duck.



The Scherr midget-type adjustable-limit snap gauges.

The textile is made either by combining glass and asbestos fibers to form yarns or by combining glass and asbestos yarns in the weaving operation. The strength of the material is primarily attributable to the glass, while the asbestos increases abrasion resistance. Owens-Corning Fiberglas Corporation.

Spot Welder for Structural Sections

The Model "C" welder is a larger companion model to the Model "B" standard rocker-arm welder recently announced. It is capable of handling in continuous production the spot welding for aircraft and other types of equipment of "structural" aluminum sections up to 1/8-in. Alclad.

Designed for a conservative production rate of 1,000 to 2,000 spots per hour when welding heavy sections, the welder is rated at a maximum point pressure of 6,500 lbs. (at 90 lbs. airline pressure). Deflections even under such conditions are held to a minimum, it is stated.

The welder will handle work of fairly large size, throat depth being adjustable from 36 to 42 in. and throat opening from 7 1/2 to 17 1/2 in. In addition to the normal 1-in. working stroke of the rocker arm, the arm is also provided with a retracting stroke that provides a 4 1/2-in. clearance between points to permit insertion of flanged work. This retracting stroke is controlled through one of the dual shrouded foot switches provided with the machine.

Controls are provided for three different pressure conditions. Normal welding pressure is applied by depressing the foot switch. Forging pressure is applied automatically. To apply light pressure for tip dressing a toggle switch is thrown on the machine and the foot switch is depressed as for welding. Upper and lower arms are designed to use standard electrodes and holders, although refrigerated welding points may also be used if desired. Progressive Welder Company, Detroit.

Rotary Broaches

The Shearmaster Rotary Broach is designed to remove metal by a true shearcutting knifelike action. The chips resemble steel wool in form and texture. Because the cutting edge is in the form of a circle, the makers state that there is no tendency to produce elliptical or uneven holes.

In the new method used with this tool the broach rotates as it cuts. The broach itself is made with a high spiral or helical cutting edge and, when end pressure is applied, the helical cutting edge removes metal in a shearcutting manner. It is said that the broaches may be sharpened from five to 30 times before they wear undersize. They are being marketed with straight shanks only in sizes from 1/4 to 1 in. by one-sixteenths, and from 1 1/8 to 1 1/2 in. by eighths. Larger sizes up to 6 in. can be supplied on special order. At present the broaches are made only from high-speed steel. Later, the manufacturer intends to make them with tungsten carbide cutting edges. Shearcut Tool Company, Los Angeles.

Binocular Microscope

The Spencer Binocular Microscope for inspection and control of surface finish retains natural, three-dimensional vision but magnifies the object many times. Because of a wide field, it will cover a relatively large area of the object. It is claimed to give unusual depth of focus and brilliant resolution of detail.

Through these optical characteristics, the microscope is not limited to the inspection of the quality finish but will detect accidental defects or imperfections before machining and assembly operations have taken place.

For the dual purpose of overall inspection and finish control, a wide choice of optics is available. The microscope will also serve for simple micrometallographic observations, where magnifications of 100× or less are sufficient. When equipped with a micrometer eyepiece, limited actual measurements may be performed as well. George Scherr Company, Inc., New York.

Midget Gauges

Four new models of adjustable-limit snap gauges, known as "midget-type gauges," are manufactured in accordance with American Gauge Design Standards. They are designed for checking and inspecting extremely small and delicate parts. The midget gauges can be set to handle work from 0.000 to 0.760 in. George Scherr Company, Inc.

Aneroid Switch

The Class 9315 aneroid switch has been designed for the close control of engine superchargers. It offers possibilities also in other applications involving electrical control responsive to altitude change.

The aneroid switch is composed of a precision switch mechanism actuated by a sensitive diaphragm or bellows of the evacuated and temperature-compensated type. The entire mechanism is mounted within a die-cast, anodized, aluminum housing provided with gasketed cover sealing the internal mechanism from the atmosphere. The manifold or atmospheric pressure connection is through a 1/8-in. tapped hole. The unit is provided with an approved two-prong, pressure-proof fitting for plug-in electrical connection to the switch. Mounting is provided by means of a three-

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From TWA's 1943 Report

Total Passenger Miles	249,352,254
Total Passengers Carried	336,388
Average Passenger Trip, Miles	750
Mail Carried, Pounds	15,039,800
Express and Freight Carried, Pounds	7,553,878

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point shockproof mount designed to minimize vibration and shock effects.

The switch is suitable for use over a temperature range of −65° to +160°F. The operating range is up to 35,000 ft. with a minimum differential of 1,000 ft. The net weight of the device is 24 oz. At 28 volts d.c. the switch will handle up to 25 amp. in-rush current on the solenoids and other parts. Square D Company, Regulator Division, Detroit.

Push-Type Circuit Breaker

The Class 9310 manual reset circuit breaker has been developed to provide an improved unit for use in the protection of low-voltage circuits not requiring switching. Although especially designed for aircraft use, these devices are also suitable for other mobile units having power sources up to 30 volts d.c.

The bimetallic trip element gives time-limit protection against small momentary overloads as well as instantaneous protection on heavy overloads and short circuits. Each breaker is calibrated and factory-sealed. After tripping it is only necessary to push the reset button down to its farthest position.

The Class 9310 circuit breaker is available in sizes 5 to 50 amp. The unit is of nontrip-free construction, and all devices are equipped with luminous indicating rings visible on trip in darkness and with a red indicating ring for daylight indication. Square D Company, Regulator Division.

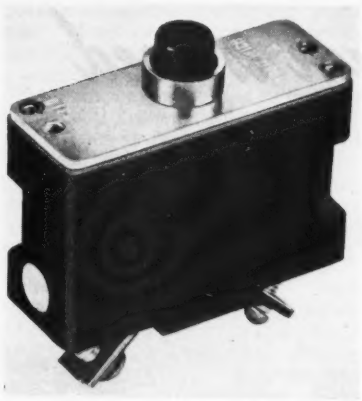
One-Piece Lock Nut

Designed to retain its grip despite severe vibration, a new type of one-piece self-locking nut is intended to meet Army and Navy specifications for numerous items of war equipment, including aircraft. It is now being made in 14 bolt sizes, from $\frac{1}{4}$ to $1\frac{1}{2}$ in., with National Coarse or National Fine thread.

The principle of the design is based on subjecting what appears to be an ordinary nut to a compressing process under which the upper part of the threaded portion is made slightly elliptical while the lower threaded portion remains circular. The nut is precisely faced and any regular wrench will fit it. It can be screwed on a normal bolt by hand about half way and then requires the use of the wrench. Once the threads are entirely on the bolt, the nut locks itself by utilizing the natural elasticity of the metal, either steel or bronze. The maker states that the nut locks at any desired point on the bolt, does not harm the bolt threads, and can be used repeatedly. Stover Lock Nut and Machinery Corporation, Easton, Pa.

Machines for Sealing Aircraft Tubing

The Tri-Seal machine for sealing ends of aircraft tubes is operated by one person and is reported to seal as many tubes as would require 43 operators by hand methods. The materials used for seals are a pressure-sensitive fabric adhesive tape, such as furnished by Bauer and Black, and a fiber disc. The tape



The Square D Company's push-type circuit breaker.

comes in rolls of various widths and the discs are precut in various diameters. The cycle of operation is less than 2 sec. per seal or 1,800 seals per hour.

At each cycle, tape is automatically fed in sufficient length to cut into a square and the fiber disc is applied to the center of the square. The operator then inserts the tube into a guide in centered relation to the disc and exerts a slight pressure to contact a microswitch that actuates the folding and pressure-applying device around the tube or nut. Upon withdrawing the sealed tube the machine is automatically reset for repeat operations.

Plain, beaded, and threaded tubes and tubes that carry fittings may be sealed with this machine. The fiber disc covers the opening completely, and the square of tape folds over and wraps the fittings. The resulting seals are claimed to be completely puncture and tamperproof. While they are easily removed, they cannot be replaced, and any tampering with them is easily detected. The tape wrap is easily removed, leaving the joint surfaces clean and ready for application.

Machines are made in three sizes: No. 1 for plain tubes of $\frac{1}{4}$ to $\frac{7}{8}$ in.; No. 2, $\frac{7}{8}$ to $1\frac{1}{2}$ in.; No. 3, $1\frac{1}{2}$ to $2\frac{3}{4}$ in. Slight variations in tube sizes apply to beaded tubes and tubes with nuts. The machines are identical in all respects except in the size of the tape feeder and the sealing head. T. R. I. Engineering Company, Los Angeles.

Etching Fluid Prepares Aluminum Surfaces for Spot Welding

For rendering aluminum surfaces chemically and metallurgically clean in preparation for spot welding, a product named "Turco Vulco-Etch" has been developed. It is a chemical bath compounded to free aluminum-alloy surfaces of oxides, corrosive salts, and tenacious grease and oil films.

The etching fluid is intended to prepare the foundation for sound spot welding by assuring the necessary chemically and metallurgically clean surface. Cleaning and etching are accomplished by a 5- to 20-min. dip in the solution. Unheated, wood-lined, rubber-lined, or crockery tanks are used. The material rinses freely in fresh, cool, running water. The solution is claimed to be long-lived and may be used for months without change. Turco Products, Inc., Los Angeles.

Portable Circuit-Tester

The Umco analyzer is designed to analyze and simplify the finding of electrical and wiring troubles in aircraft, especially for field service. It includes a multiple-scale ammeter, a multiple voltmeter, and an ohmmeter. These instruments are automatically connected into the proper circuits by a selector switch so that the analyzer can measure the currents and voltages in any of the circuits used in the airplane. It can also be used in checking for open circuits and short circuits and for measuring the resistance of any circuit elements.

To test any particular circuit, a tee adapter is inserted into the circuit and the selector switch is used to select the proper testing circuit. Since the three primary indicating instruments are all located in the analyzer and can be connected to the circuit under test, no auxiliary instrument is necessary.

The maker states that voltage regulators can be adjusted on the airplane in approximately 30 min., compared to 1 to 3 hours required by the "set and try" method. In a recent demonstration the reverse-current relay, along with six other circuits, was completely checked in less than 20 min.

The analyzer is portable, compact, and easily handled. It is contained in a dust-tight and watertight case, about 10 by 15 by 12 in., with a removable compartment for accessories. The total weight is approximately 25 lbs., including all accessories. The accessories include tee adapter with 20 ft. of cord and plug and the necessary master plugs for the various applications. The accessory sections may be removed while the instrument is in use. United Hydraulic Manufacturing Company, Los Angeles.

Nonmetallic Heating and Ventilating Ducts

Practically all metal has been eliminated from heating and ventilating air-duct systems of certain aircraft by the discovery and development of a fire-resistant asbestos product.

Performance of delicate instruments, as well as the efficient operation of radio, is reported to have improved as a result of the nonmagnetic qualities embodied in these products. Construction is such that should this multiflex material be penetrated by bullets or aerial flak it can be easily and speedily repaired, since there is no flare in the material after the projectile passes through the duct.

Made of fabric, asbestos, and a coating of synthetic resin, this new product is said to make possible the lightening of the material used in the heating and ventilating air-duct systems by more than 10 per cent. The development of

Why Chromium is used in ENGINEERING STEELS

Small amounts of chromium (0.2–2.0%) are used in many engineering steels because chromium increases—

- Hardenability
- Toughness
- Impact Resistance
- Wear Resistance
- Ductility at high tensile strength

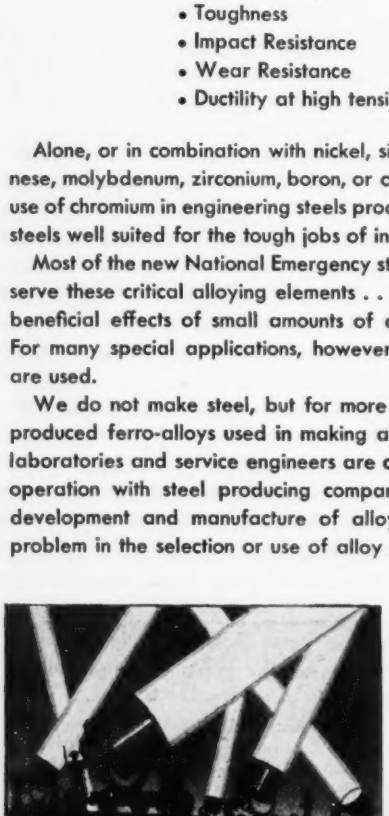
Alone, or in combination with nickel, silicon, vanadium, manganese, molybdenum, zirconium, boron, or other alloying agents, the use of chromium in engineering steels produces markedly improved steels well suited for the tough jobs of industry.

Most of the new National Emergency steels . . . designed to conserve these critical alloying elements . . . take advantage of the beneficial effects of small amounts of chromium (0.20–0.60%). For many special applications, however, higher chromium steels are used.

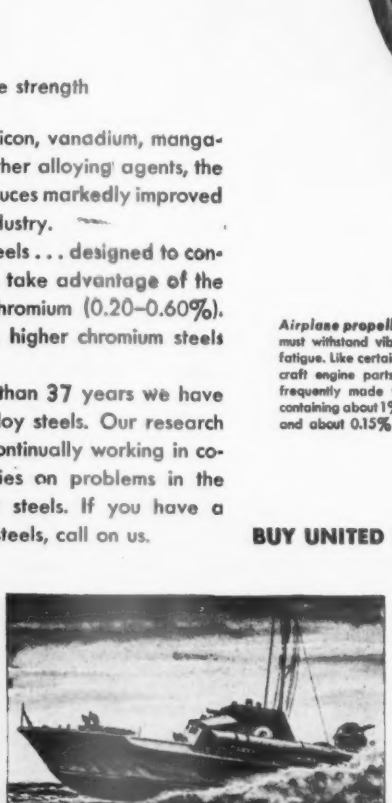
We do not make steel, but for more than 37 years we have produced ferro-alloys used in making alloy steels. Our research laboratories and service engineers are continually working in co-operation with steel producing companies on problems in the development and manufacture of alloy steels. If you have a problem in the selection or use of alloy steels, call on us.

Airplane propeller blades must withstand vibration and fatigue. Like certain other aircraft engine parts, they are frequently made from steels containing about 1% chromium and about 0.15% vanadium.

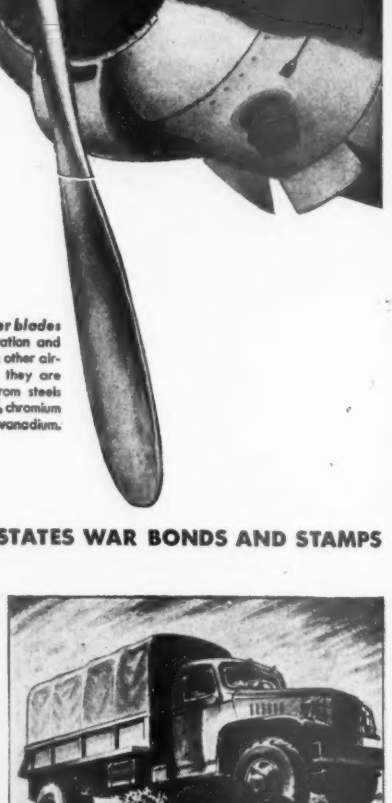
BUY UNITED STATES WAR BONDS AND STAMPS



Ball Bearings for equipment that must move freely and quickly must resist abrasive wear, and keep true shape. Most precision ball bearings are made of 1.2-1.5% chromium steel with 0.2-0.5% manganese.



Marine Engine Crankshafts for patrol vessels take a terrific pounding. Men's lives depend on their durability and strength. These crankshafts are frequently made from a 1.0% chromium steel with manganese, nickel, and molybdenum.



Truck Gears must be tough, durable and wear resistant. Gears, steering knuckles, springs, pinions, and many other truck parts are now being made from steels containing up to 1% chromium with less amounts of other elements.

ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street New York, N. Y.
In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario

Electromet
Trade Mark
Ferro-Alloys & Metals

this pliable fabric has also facilitated high-speed production schedules in the aircraft industry, for it can be twisted and turned or completely deformed and can easily be returned to its original shape without effort.

The simplicity of construction and the ease of application and installation of this new system allow the material to be formed into radii and intricate angles and shapes for fittings in a matter of minutes. It excludes the taking of patterns and the bending and fitting of joints and elbows with strategic materials. These systems are assembled and cemented together with a special synthetic-rubber compound.

Other uses have been found for this type of flexible unit. Machine-gun shell-ejection chutes have been developed. These chutes are connected to the ejection chamber of machine guns. Discharged shells from the gun fall from the ejection chamber into the chute, which guides them to a receptacle.

A special system has been devised by which bombsights are kept at exact temperatures to insure proper working at all times. Windshields equipped with extensible defroster hose are kept from frosting or steaming as a result of a similar method of construction.

The new ducts are used to heat carburetors, as turbocooling duct, header ducts, generator-blast tubes, fire-wall seals, and many other working parts on planes. These applications are also important for cooling or heating cabins of combat and cargo craft. United States Rubber Company.

New Basic Resin Available

The availability for limited commercial and experimental use of a new basic resin is announced. The new resin, named "Duralon," a furane derivative, is characterized by what is described as the lowest water absorption of any organic resin, insolubility (after activation) in any solvent or combination of solvents, high electrical resistivity, stability in storage and handling, and ease of workability.

In its pure form it is a heavy, viscous liquid, dark maroon in color. On incorporation of catalysts and application of mild heat, it reverts to an extremely hard, dense, black substance. Varying physical, chemical, and electrical properties can be developed in the base resin by incorporation of the usual fillers and lubricants. In certain stages it can be readily machined by drilling, milling, turning, sanding, grinding, etc. The resins are readily soluble, before activation, in many inexpensive hydrocarbons as well as in ketones and chlorinated solvents.

While preliminary studies indicate that it possesses definite molding possibilities, its immediate importance is as an impregnant, as a laminating and bonding agent, or as a protective coating material. It is in these applications that its resistance to moisture, its insolubility in solvents (even at elevated temperatures), and its versatile surface characteristics (ranging from a high gloss to a crinkle finish) may prove valuable in solving present-day problems. Many of these properties can be attributed to the unusual wettability of the unconverted resin.

Solutions may be applied as coatings by any of the conventional processes or may be used for impregnation of porous materials such as plywood, asbestos, glass fibers, or other fibrous materials; as a bonding agent for abrasive compounds, powdered metals, etc.; or for adhesive bonding of fibrous materials to each other.

Prior to the application of heat, Duralon coatings are soft and flexible. As heat is applied (a mild bake is usually sufficient), the coatings remain thermoplastic up to a point, at which time they become increasingly thermosetting, depending upon the type and extent of activation. No particular surface preparation is needed before application of the coatings.

After baking, coatings of this material are hard and somewhat more brittle than coatings of the thermoplastic type. They show practically zero water absorption, are unaffected by solvents, and offer resistance to nonoxidizing acids and alkaline materials. Other resins, shortly to be made available, are completely nonthermosetting, and have certain plasticizing, wetting, and tackifying properties over wide temperature ranges. The United States Stoneware Company, Akron, O.

Surface-Finish Comparison Standards

Surface-finish comparison standards are intended to enable manufacturers to specify and check surface roughness. The set of standards is composed of 23 specimens with a roughness range from 2 millionths of an inch (root-mean-square) to 500 millionths of an inch (root-mean-square). The blocks are made of stainless steel and include representative specimens of all ordinary machine tool operations, such as polishing, grinding, turning, shaping, milling, etc. Each specimen is engraved with the machine operation and microinch reading.

A machinist or inspector can check the roughness of a machined surface by comparing the standard specimen with the part under test. The human fingernail drawn across the surface is sufficiently sensitive to detect roughness differences of only a few millionths of an inch.

Each individual specimen is kept in a separate compartment in a felt-lined walnut case. University Machine Company, Cambridge, Mass.

Lathe for Aircraft Brake-Drum Work

A heavier base casting, designed to accommodate the brake drums of airplane wheels, is a feature of the No. 303 brake-drum lathe. Built out several inches more than formerly, the base permits airplane wheels to fit under that section.

The independent heavy-duty grinder attachment finish-grinds heavy cast-iron drums at the same time the drums are being turned and saves the time of one complete operation. The 3-in. hollow spindle not only revolves but slides horizontally, permitting ready access to the interior of the drums, fast setup, rigid support of the work, and easy introduction of the grinder.

Five feeds forward and five feeds reverse, together with three speeds, provide the proper and necessary speeds and feeds for all brake drums. Van Norman Company, Springfield, Mass.

Airport Runway-Light Control Scheme

Recently, airports have adopted the "static type" regulator for contact lights used to outline airport runways because it has no moving parts. It provides a high power factor at all intensity settings even though loaded only partially. The assembly comprises all switches, relays, and transformers needed for remote operation from the control tower.

Brightness switching is accomplished by five relays that select taps on the secondary of the input transformer. This transformer feeds into a resonant circuit, and output currents may be selected to provide 100, 30, 10, 3, and 1 per cent of normal brightness. The static type resonant circuit provides constant current for all five current settings independently of any load within the rated capacity of the regulator. The 7½-kw. rating is based on 6.6 amp. secondary current. Westinghouse Electric & Manufacturing Company.

Wrought Magnesium Alloys

Whitelight wrought magnesium alloys, fabricated as rods, bars, shapes, tubes, hollow extrusions, wires, sheet, strip, circles, blanks, and forgings, are available in four widely applicable alloy compositions, as well as pure magnesium. The alloys are manufactured principally in high-purity compositions for maximum uniformity and corrosion resistance. Commercial purities are also available if economy is the major factor. The commercial alloys are designated as FS, J, O, and M, while the high-purity nomenclature is FS-1, J-1, and O-1. The manufacturer states that selection of alloys should be made for a specific application only when all of the pertinent considerations are at hand, and FS-1 is recommended as having the greatest utility and the best general combination of properties. Where higher strengths are required J-1 or O-1 is used. Of the two, J-1 possesses better workability. Where best weldability, lowest cost, and only moderate strengths are required, M alloy is used. It does not usually possess the machinability and surface smoothness of the others.

Stocks of standard sizes of rods, bars, sheets, and tubes are carried in the several alloys. Standard sizes in round rod and tubes are considered as 1/16-in. increments to 2 in. and 1/8-in. increments to 3 in. White Metal Rolling & Stamping Corporation, Brooklyn.

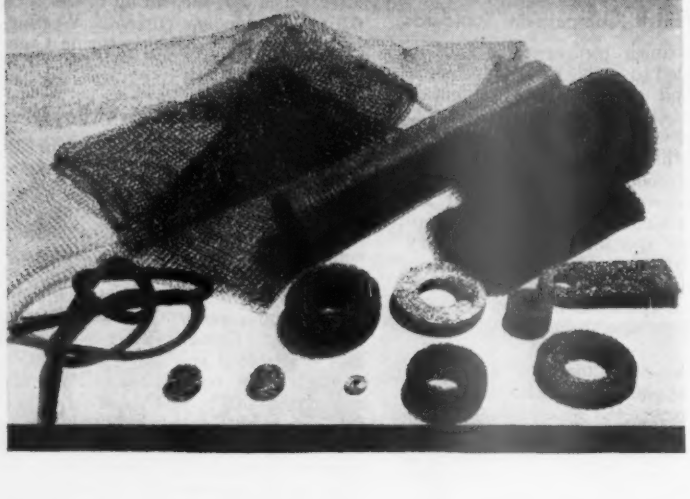
"I want A FLEXIBLE GASKET TO WITHSTAND 2000° F." said the airplane part maker

"I want A FEEDWATER CLEANER THAT CORROSION WON'T CRIPPLE" said the railway mechanical engineer

"I want A FINE TUBE GRID THAT WON'T SAG" said the electronic tube maker

"I want A LASTING WICK FOR AIRPLANE HEATERS" said the cabin heater maker

All found their answer in KNIT METAL MESH



Knit metal mesh has provided the answer to a lot of tough problems. Perhaps it's the answer to one of *your* problems, too.

The special *linked loop* design assures flexibility, high resistance to breakage, and bias strength.

The fabric holds together even when made of very fine wire (.0045" diameter) and with as few as 4 or 5 openings to the inch. It can be compressed lightly for air, liquid or gas filters . . . tightly for gaskets.

In applications requiring extra strength, toughness, resistance to high temperatures, corrosion resistance, and other specialized properties, INCO Nickel Alloys are used.

Thus, Inconel knit mesh is used for airplane exhaust manifold gaskets that must retain flexible strength at 1500° F., and for capillary wicks in airplane cabin heating units. Pure Nickel is used in a design that prevents sagging of fine mesh electronic tube grids.

Rustless, corrosion-resistant knit Monel pads are used to filter grit and scale from locomotive feedwater before it is pumped back into the boiler. The Monel mesh made from .006" wire, permits free flow of the water as there is 96% free space . . . 15,000 square inches of filtering area in a 14" x 20" pad. The pads are readily cleaned every four or five weeks in Oakite and Soda Ash Solution.

For further information, write direct to Metal Textile Corporation, Orange, N. J., makers of knit metal mesh, or to: The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

"I want A BETTER AIR FILTER MEDIUM" said the filter manufacturer

"I want A FLEXIBLE STRAP THAT WON'T JIGGLE LOOSE" said the magneto maker

INCO NICKEL ALLOYS

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • "Z" NICKEL • NICKEL • *Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings*

Institute News

Boeing Dedicates Wind Tunnel to Edmund T. Allen

The new Boeing wind tunnel was dedicated on April 22 and was named the Edmund T. Allen Memorial Aeronautical Laboratories in honor of the test pilot and aeronautical engineer who lost his life last year in an airplane-test accident.

The dedicatory ceremonies were featured by the posthumous award of the Guggenheim Medal for 1943 to Mr. Allen. The presentation was made to Mr. Allen's widow, Mrs. Florence Allen, by Philip G. Johnson, President of the Boeing Aircraft Company on behalf of the Daniel Guggenheim Medal Board of Award. The tunnel was officially placed in operation by Mrs. Allen following the award.

Stated to be the fastest of any wind tunnel in the country, with test sections more than 2 ft. in diameter, the new Boeing experimental laboratory can produce gales in the 700 m.p.h. range through its 13-ft. wide test section. The new tunnel is a self-contained research unit, complete with model-design and construction facilities and computing laboratories, as well as actual testing quarters. It has numerous conveniences and refinements never before built into any single tunnel and is designed for efficiency of operation.

Model planes with wingspreads up to 11 ft. or full-scale airplane sections of the same maximum size can be tested in the new Boeing tunnel. An outstanding feature is that all tunnel controls are centralized in the panel board before the test section, at the same place where model observations are made.

Mrs. Florence Allen holds the Daniel Guggenheim medal for 1943, awarded posthumously to Edmund T. Allen.

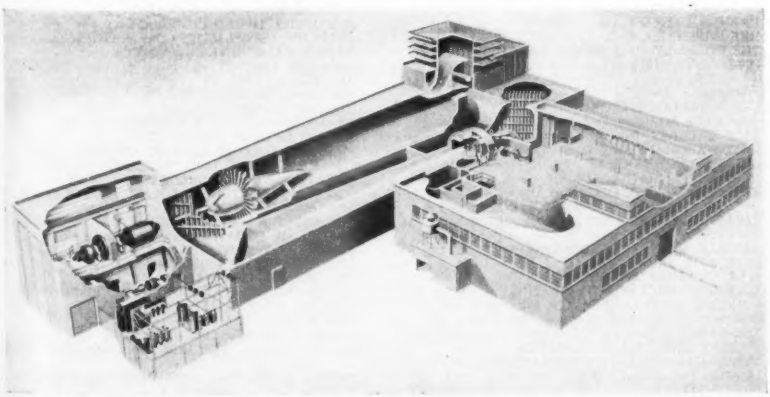
The tunnel's flow of air is created by a propeller-type of fan 24 ft. in diameter. This fan consists of 16 laminated spruce blades designed and built by Boeing engineers. It is mounted on the end of a 37-ft. steel driveshaft, 16 in. in diameter, which connects the fan with the motor and clutch.

The synchronous electric motor, built by Westinghouse, has a rating of 18,000 hp. and maintains a constant speed of 514 r.p.m. The speed of the fan is regulated by a magnetic coupling or "clutch," several times larger than any previously built, which is installed between the motor and the fan. This coupling, built by the Dynamatic Corporation, operates on a magnetic principle and regulates the speed of the fan so that airplane models or parts can be subjected to exact wind conditions.

An intricate Boeing-designed system of balances, capable of accurately measuring lift forces from $^1/_{10}$ to 8,000 lbs., records all the forces, such as lift, drag, yaw, pitch, roll, and side force, acting on the model being tested. An automatic printer, which is part of an array of instruments and dials on the main control board outside the test section, will, at the touch of a button, record and print on a tape all the forces acting on the model at that instant.

The tunnel bore is a complete, continuous-return structure that follows an approximately rectangular course 450 ft. in length. It varies in size from 8 by 12 ft. in the "throat" or test section to 27½ by 27½ ft. at the largest part. Accurate concrete work on the interior walls was required to maintain the close tolerances.

An aerodynamics laboratory adjoins the wind tunnel, with a reception lobby and model-building shops on the first floor and engineering offices and tunnel-operations room on the second. This arrangement permits engineers to design, build, and test models in the same building.



An artist's cutaway sketch of the new Boeing wind tunnel shows the power unit, operations room, and office quarters.

Orville Wright Honored

Orville Wright, an Honorary Fellow of the Institute, has been elected to an honorary life membership in the Aeronautical Chamber of Commerce of America, Inc. He was one of the original members of the Chamber when that group was organized on December 28, 1921.

The following new officers of the Aeronautical Chamber of Commerce have been elected: Chairman of the Board of Governors, E. E. Wilson, Vice-Chairman, United Aircraft Corporation; Vice-Chairman, Donald W. Douglas, President, Douglas Aircraft Company, Inc.; President, James P. Murray, Vice-President, Boeing Aircraft Company; Vice-Presidents, Lawrence D. Bell, President, Bell Aircraft Corpora-

An Appreciation

to Corporate Members of the

Institute of the Aeronautical Sciences

Listed below are the leading aeronautical and industrial companies that make possible the publication of the *Journal of the Aeronautical Sciences*.

They enable the Institute to publish scientific and technical papers in the *Journal* and to devote its pages exclusively to editorial material.

Dues from individual members which would normally be used to publish this scientific and engineering quarterly are thus released for additional services to the profession and industry.

Advertising defrays the cost of publishing the *Aeronautical Engineering Review* and the *Aeronautical Engineering Catalog*.

These publications provide a comprehensive technical information service for the benefit of the aircraft and related industries.

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tion, and LaMotte T. Cohu, Chairman, Northrop Aircraft, Inc.; Treasurer, John E. P. Morgan; and Secretary, Col. Harrison Brand, Jr.

National Light Aircraft Meeting

The National Light Aircraft Meeting of the Institute, held at the Horace H. Rackham Educational Memorial, Detroit, Mich., on April 27 and 28, was one of the most successful meetings ever sponsored by the Institute.

Over 400 members and guests attended the Technical Sessions on the afternoons and evenings of the two days to hear the 22 papers scheduled for presentation. Particular interest was shown in the paper presented on Thursday evening by W. A. M. Burden, Assistant Secretary of Commerce (for Air), on "The Government's Place in the Development of Private Flying." In the afternoon of the same day, Edward P. Warner, Vice-Chairman of the Civil Aeronautics Board, spoke on "Regulatory Standards for Light Aircraft Design." This paper is printed in full in this issue of the AERONAUTICAL ENGINEERING REVIEW.

No reprints of the meeting papers are at present available, but it is planned to publish most of them in forthcoming issues in either the JOURNAL OF THE AERONAUTICAL SCIENCES or the AERONAUTICAL ENGINEERING REVIEW.

Summer Meeting

The Summer Meeting of the Institute is to be held in Los Angeles during the afternoons and evenings of July 27 and 28. All Technical Sessions of the Meeting will be held in the Hancock Auditorium of the University of Southern California.

The Chairmen and Co-Chairmen of the four sessions are as follows:

July 27—Afternoon Session. Chairman, Dr. Clark B. Millikan, California Institute of Technology; Co-Chairman, J. Richard Goldstein, Douglas Aircraft Company, Inc.

July 27—Evening Session. Chairman, Dr. A. L. Klein, California Institute of Technology; Co-Chairman, Edward C. Wells, Boeing Aircraft Company.

July 28—Afternoon Session. Chairman, Prof. Elliott G. Reid, Stanford University; Co-Chairman, E. J. Horkey, North American Aviation Inc.

July 28—Evening Session. Chairman, Ernest G. Stout, Consolidated Vultee Aircraft Corporation; Co-Chairman, William R. Sears, Northrop Aircraft Corporation.

The Summer Meeting will consider problems of flight instrumentation, flight research, aerodynamics, and structures. A flight-testing seminar is also planned for one of the sessions.

The final program of the Meeting will be printed and mailed to all members several weeks prior to the Meeting.

Gifts to the Aeronautical Archives

Dr. A. F. Zahm gave copies of 57 letters written to him by Octave Chanute in connection with the International Conference on Aerial Navigation, Chicago, 1893. Mrs. Samuel Cabot, Jr., sent the manuscript of an unpublished paper by Samuel Cabot, *Experiments on Forms of Least Resistance to Passage Through Air*, read before the American Academy of Arts and Sciences, Boston, February 12, 1902. Nineteen aeronautical books were received from Francis Lieber, of Wilmington, Del.

Two crocheted bedspreads designed with an I.A.S. monogram and the balloon in which Jean Pierre Blanchard and Dr. John Jeffries made the first air crossing of the English Channel in 1783, were made by and received from Mrs. Reginald M. Cleveland.

Mrs. Bella C. Landauer sent 572 air transport labels, adding to the generous aeronautical collections she had previously given. Two carved oak period arm chairs for the King James Library in the Guggenheim mansion at Sands Point were given by Lee Warrender. Dr. Otto Kallir gave two medals, adding to his previous gifts.

Through the courtesy of Miss Jacqueline Cochran, a breast wings, lapel pin, and cap insigne of the Women's Air Force Service Pilots were received. Company insignia and badges were received from The Aero Tool Company; Aircooled Motors Corporation; Aircraft Hardware Manufacturing Company; Aircraft Mechanics, Inc.; Aero Equipment Corporation; Charles H. Babb Company; Briggs Manufacturing Company; British Airways, Baltimore; Canadian Pacific Air Lines; Cox & Stevens Aircraft Corporation; Flottorp Propeller Company; The General Tire & Rubber Company; Kollsman Instrument Division of the Square D Company; Link Aviation Devices, Inc.; Northwest Airlines, Inc.; Ranger Aircraft Engines Division of the Fairchild Engine & Airplane Corporation; REF Aircraft Corporation; Summerill Tubing Company; and Switlik Parachute Company. Abbott Laboratories, through the courtesy of William G. Chappell, gave 13 mounted reproductions of naval aviation paintings.

The British Air Commission sent 30 British Air Ministry Translations to add to the large number it had previously given. A copy of *Scribner's Monthly* for February, 1879, containing Edmund Clarence Stedman's article on "Aerial Navigation," was received from John R. Cuneo. Twenty-two issues of *Aerial Age* and *Flying* were sent by the Stout Research Division of Consolidated Vultee Aircraft Corporation through the courtesy of Waldo D. Waterman. Harold J. Roig gave pamphlets on Pan-American-Grace Airways Inc.

Among the donors of other gifts were N. W. Ayer & Son; the British Information Services; Chandler-Evans Corporation; Continental Air Lines, Inc.; Goodyear Aircraft Corporation; Graduate School of Business Administration of Harvard University; Hodder & Stoughton, Ltd.; Howard Aircraft Corporation; Jack & Heintz, Inc.; Pennsylvania-Central Airlines Corporation; U.S. Forest Service; Division of Aeronautics of the Library of Congress; Office of the Coordinator of Inter-American Affairs; Office for Emergency Management; Office of Civilian Defense; War Manpower Commission; Weather Bureau; and Congressional committees on appropriations, claims, postwar economic policy and planning, and printing.

New Corporate Member

Lavelle Aircraft Corporation, Newtown, Bucks County, Pa., has recently become a Corporate Member of the Institute. It specializes in the production of aircraft components of metal construction, such as riveted aluminum-alloy structures, welded aluminum tanks, welded chromoly steel structures, and resistance welding of stainless steel. The company has manufactured in substantial quantities parts ranging in size and complexity from small screens for air-induction systems to the complete fin assembly for the Curtiss C-46 Commando transport. It also produces specialties, such as machine-formed match angles of extruded shapes for attachment of control surfaces to the fuselage. Facilities and equipment for practically all processes used in the constructions noted, as well as tool design and construction, are available within the organization.

In addition to the production activities mentioned, an engineering department is maintained for service to customers on production or development problems and for research on company projects.

Sections and Branches

Buffalo Section

A business and technical meeting of the Buffalo Section was held on April 24 at the Amherst Central High School. New officers were elected as follows: Chairman, Harold V. Hawkins; Vice-Chairman, Paul E. Hovgaard; Secretary, John B. Scalzi; and Treasurer, Walter W. Bird.

Raymond A. Young, of the Bell Aircraft Corporation, was the speaker of the evening and gave a talk on "Helicopter Development at the Bell Aircraft Corporation," illustrated by motion pictures. Mr. Young answered questions after the showing of the picture.

Catholic University of America

At the March 2 meeting the film *PBY Record Breakers* was shown, followed by a short business meeting. At a meeting on March 10 Mr. Buckley, of The Glenn L. Martin Company, gave a short talk about the methods used in

forming curves in sheet metal used in aircraft construction. He also presented a motion-picture film showing the China Clipper and the B-25 Marauder.

A motion-picture film about the PT-19, released by the Fairchild Aircraft Division of Fairchild Engine and Airplane Corporation, was shown at a meeting on March 16. It follows the building of the PT-19 through the processes of construction and flight test to the time of delivery to the Army Air Forces. On March 28 a meeting was held at which the film *Flying Fortress* released by Boeing Aircraft Company, was presented.

Polytechnic Institute of Brooklyn

A joint meeting of the Aeronautical, Mechanical, and Civil Engineering societies was held on May 4. This was the first time in the history of the Polytechnic Institute that such a joint meeting has been held.

The guest speaker, Thomas D. Perry, of the Resinous Products and Chemical Company, spoke on "Modern Plywood and Glues." His discussion concerned the manufacture and use of plywood and the advantages it offers, particularly in connection with aeronautical engineering.

Rensselaer Polytechnic Institute

A regular meeting was held on April 28. Two motion pictures were shown: the first about airway flying in the United States and the second about radio aids to aerial navigation.

Tri-State College

The following officers were elected: Chairman, Fred Guendel; Vice-Chairman, William Gettig; Secretary-Treasurer, Marion J. Drozdziel.

University of Alabama

On May 1 the Alabama Student Branch held a joint meeting with other engineering societies. A motion picture titled *Formica*, giving information about plastics and their manufacture and uses, was shown.

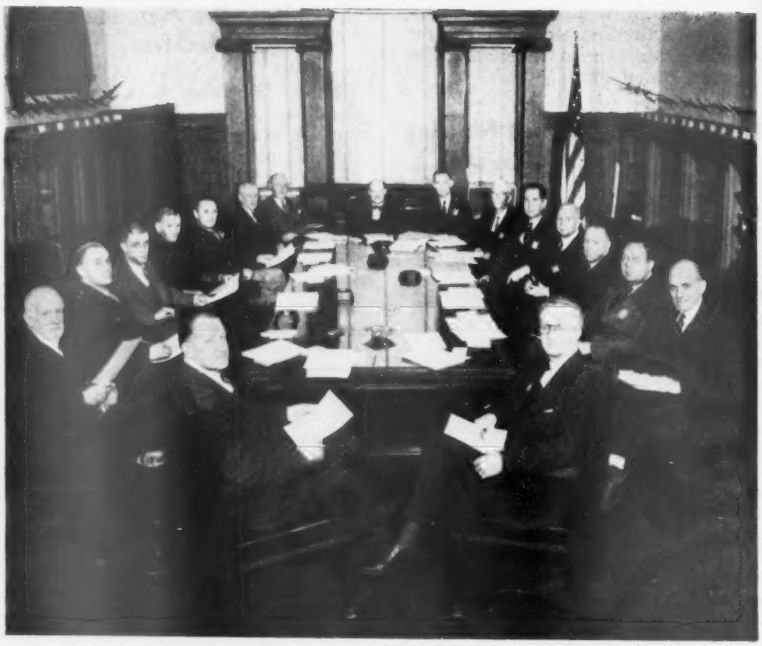
News of Members

Cecil W. Armstrong has been appointed Chief Development Engineer of the Plastics Division of the Continental Can Company, Inc. He is also serving as a member of the Subcommittee on Wood and Plastics for Aircraft of the National Advisory Committee for Aeronautics.

John Ashton has joined S. F. Bowser, Inc., as Production Manager.

Gerald H. Backer has joined the Bureau of Aeronautics of the Navy Department as Associate Engineer (Aeronautical).

Murray C. Beebe, Jr., has been made Development Engineer with Aerojet Engineering Corporation.



A photograph of members of the National Advisory Committee for Aeronautics, taken at its Semiannual Meeting on April 20, 1944.

Front, left to right: William Littlewood, Vice-President—Engineering, American Airlines; Dr. Theodore P. Wright, Director, Aircraft Resources Control Office, Aircraft Production Board. *Left to right:* Dr. William F. Durand, Professor Emeritus of Mechanical Engineering, Stanford University, California; Major Gen. Oliver P. Echols, U.S.A., Assistant Chief of Air Staff, Matériel, Maintenance and Distribution, Army Air Forces; Dr. Vannevar Bush, Director, Office of Scientific Research and Development; Vice Adm. John S. McCain, U.S.N., Deputy Chief of Naval Operations (Air); Major Gen. Barney M. Giles, U.S.A., Chief of Air Staff, representing Gen. Henry H. Arnold, Commanding General, Army Air Forces; Dr. Orville Wright; Dr. George W. Lewis, Director of Aeronautical Research, N.A.C.A.; Dr. Jerome C. Hunsaker, Chairman, N.A.C.A.; John F. Victory, Secretary, N.A.C.A.; Dr. Charles G. Abbot, Secretary, Smithsonian Institution; Dr. Edward Warner, Vice-Chairman, Civil Aeronautics Board; Dr. Lyman J. Briggs, Director, National Bureau of Standards; Rear Adm. Ernest M. Pace, U.S.N., Special Assistant (Material), Bureau of Aeronautics; Hon. William A. M. Burden, Assistant Secretary of Commerce; Dr. Francis W. Reichelderfer, Chief, U.S. Weather Bureau.

Eugene S. Davidson has been commissioned a Lieutenant in the U.S. Naval Reserve.

Alex M. Dussel has entered the U.S. Naval Reserve as a Midshipman.

Robert R. Gibbs has become connected with Hughes Aircraft Company as a Stress Engineer.

Karl P. Grube has been appointed Manager of the newly created Corporate Termination Claim Committee at the Douglas Aircraft Company, Inc.

Clyde E. Heaton has received his commission as an Ensign in the U.S. Naval Reserve.

Hall L. Hibbard, Vice-President and Chief Engineer of Lockheed Aircraft Corporation, has been given direction of the consolidated engineering departments of Lockheed Factory A and Factory B.

Thomas C. Hill has been advanced to head a new combined Controls-Hydraulics Design group at The Glenn L. Martin Company.

Ludwig B. Kalinowski, formerly Assistant Chief Engineer of Edo Aircraft Corporation, has joined Kellett Aircraft Corporation in the capacity of Assistant Chief Engineer.

Bradley G. Kohr has joined McDonnell Aircraft Corporation as Project Weight Engineer.

Wolfgang Langewiesche has joined Chance Vought Aircraft Division of the United Aircraft Corporation as a Test Pilot in the Flight Test Department.

Sanford A. Moss received the New England Award for 1944, presented by the Engineering Societies of New England, Inc., in recognition of his work in connection with airplane superchargers.

David J. Peery has been appointed head of a new curriculum in aeronautical engineering at The Pennsylvania State College.

Robert A. Pope has become connected with the Bomber Division of Ford Motor Company as Liaison Engineer.

Ernest R. Reff has transferred to Northwest Aeronautical Corporation as a Design Engineer.

David G. Reid has joined ChanceVought Aircraft Division of United Aircraft Corporation as Materials and Process Engineer in development and research.

James M. Robertson has become connected with the Douglas Research Laboratories of the Douglas Aircraft Company, Inc., at Santa Monica, Calif.

Frederick C. Rowley has transferred to Grumman Aircraft Engineering Corporation as an Engineering Test Pilot.

Karl K. Schakel has been appointed Chief Engineer of Aerotor.

Mac Short, formerly the Vice-President in Charge of Factory A Engineering at Lockheed Aircraft Corporation, has been advanced to Vice-President in Charge of Special Navy Projects, reporting directly to President Robert E. Gross. He will concentrate on the development of long-range patrol and reconnaissance bombers and other Navy projects.

Robert D. Snow has joined Consolidated Vultee Aircraft Corporation as an Aerodynamics Engineer.

Irving W. Stieglitz has become connected with Republic Aviation Corporation as a Design Engineer.

Frederick K. Teichmann has been advanced to the position of Professor of Aeronautical Engineering and Chairman of the Department of Aeronautical Engineering at the Daniel Guggenheim School of Aeronautics of New York University.

Evan Terry has been made a Development and Research Engineer at Aircraft Mechanics, Inc.

Charles A. Van Dusen has been elected President of Van Dusen Engineering Company.

Edwin C. Walton has been appointed Assistant to the President of American Airlines, Inc.

John E. Wood, formerly Airport Consultant in the firm of Poor & Wood, has been appointed Air Transport Analyst of the Port of New York Authority.

Eli A. Zeitlin has joined Consolidated Vultee Aircraft Corporation as Structures Engineer in the Development Engineering Department.

Members Elected

The following applicants for membership or applicants for change of previous grade have been admitted to membership in the grades indicated since the publication of the list in the last issue of the REVIEW.

Elected to MEMBER Grade

Beuchert, John Theodore, B.S. in C.E., Design Engineer, Weight and Balance Engineer, Consulting Engineer, John M. Thorne, Inc.

Buckell, Frank Edward, Liaison Engineer, Aircraft, General Electric Co., Ltd. (England).

Fenton, Randall Nash, Aircraft Stress Engineer, Fisher Body Div., General Motors Corp.

Gelbart, Abe, Ph.D.; Prof. of Applied Mathematics, Syracuse University.

Hamer, Ian Malcolm, B.A.Sc.; Chief Engineer, Dowty Equipment (Canada) Ltd.

Harris, Lewis Byron, Radio Engineer, Republic Aviation Corp.

Hewitt, Ellis Eberle, Chief Engineer, Westinghouse Air Brake Co.

Hohensee, Arnold Walter, B.S. in Ae.E.; Design Engineer, Goodyear Aircraft Corp.

Horn, Stanley Thomas, B.S.Ae.E.; Sr. Service Engineer, Lockheed Aircraft Corp.

Lankin, William, B.Ae.E.; Staff Engineer, The Waco Aircraft Co.

Larsson, Karl Henrik, Aviation Engineering; Chief Engineer, A. B. Aerotransport-Swedish Intercontinental Airlines.

Linnert, Theodore George, B.S.Ae.E.; Flight Test Engineer, Edward G. Budd Mfg. Co.

Marschner, Walter Karl, M.E.; Chief Draftsman, G & A Aircraft Corp.

Nilsen, Roy Theodore, B.S.Ae.E.; General Engineering, Aeronautical Engineer, United Air Lines, Inc.

Perina, Joseph, Chief Standard & Material Engineer, Republic Aviation Corp.

Rohlfs, Roland, Chief, Army Section, War Training Service, C.A.A.

Sonntag, Hermann, Group Leader and Design Engineer, Armament Group, Consolidated Vultee Aircraft Corp.

Weiss, Leonard Werner, Training Director, Brewster Aeronautical Corp.

Transferred to MEMBER Grade

Bouton, George Innes, B.S.E.; Asst. Chief Engineer, Laister-Kauffmann Aircraft Corp.

Elected to Industrial Member Grade

Gale, Charles Hanson, B.A.; Public Relations for Hill & Knowlton, Aviation Corp., Aero. Chamber of Commerce, Consolidated Vultee Aircraft Corp., etc.

Hughes, John Edward, LL.B.; Lawyer, Aviation Corp., Consolidated Vultee Aircraft Corp., & American Airlines, Inc.

Leyson, Burr Watkin, S. of M.A.; Capt., Free Lance Aviation Writer, and Consultant.

Parrish, Wayne William, M.S.; Editor & Publisher, American Aviation Associates, Inc.

van der Gaast, Harry, Purchasing Agent, American Airlines, Inc.

Elected to Technical Member Grade

Baker, Charles Lee, B.S.Ae.E.; Lead Liaison Engineer, Douglas Aircraft Co., Inc.

Borges, Louis Joseph, Jr., B.S.M.E.; Jr. Aerodynamicist, Airplane Div., Curtiss-Wright Corp.

Burkhart, Robert, B.Sc.; Aerodynamicist, Consolidated Vultee Aircraft Corp.

Clauson, Walton Evans, Liaison & Salvage Engineer, Laister-Kauffmann Aircraft Corp.

Crispin, Charles Honnold, Special Courses Instructor, Flight Operations Dept., Douglas Aircraft Co., Inc.

Dickson, Preston Edward, Aerodynamicist, Beech Aircraft Corp.

Ellis, N. L., Technical Asst., Department of Aircraft Production.

Foster, Harry Edward, Aero. Engineer, Cessna Aircraft Co.

Hartel, Charles Frederick, Jr., B.A.; Research Analyst, Consolidated Vultee Aircraft Corp.

Hwa, William Zoonghu, S.M.; Capt., Chinese Air Force.

Immel, Walter W., Asst. Group Engineer, Engineering Dept., The Glenn L. Martin Co.

Martin, Russell I., B.S. in Ae.E.; Stress Analyst, Consolidated Vultee Aircraft Corp.

Martin, William John, Flight Capt., Consolidated Vultee Aircraft Corp.

Norris, Phillip Erdice, B.S.M.E.; Jr. Aerodynamicist, Airplane Div., Curtiss-Wright Corp.

Osojnak, Boris Mladen, B.S in M.E.; Jr. Analytical Engineer, Lycoming Div., The Aviation Corp.

Reesing, Harlan Allen, B.S. in Ae.E.; Engineering Draftsman (Class "A"), El Segundo Div., Douglas Aircraft Co., Inc.

Rosenberg, Leonard H., Ae.E.; 1st Lt., Navigation Instructor, U.S. Army Air Forces.

Russell, Robert Taylor, Jr. Aero. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Ryan, Merle V., Engineer, Layout, Boeing Aircraft Co.

Ryback, William Allan, B.S. in C.E.; Sr. Stress Analyst, Goodyear Aircraft Corp.

Taylor, Wilbur Asher, A.E.; Commercial Design Dept., The Glenn L. Martin Co.

Urian, Charles Arthur, Asst. Project Engineer, Aircraft, Edward G. Budd Mfg. Co.

Weiner, Henry H., B.S. in M.E.; Aeronautical Engineer, Naval Aircraft Factory, Philadelphia Navy Yard.

Zouck, Robert Linsley, Aviation Cadet, U.S. Army Air Forces.

Transferred from Student to Technical Member

Alger, Donald Ray.

Ashland, Ralph W., B. of A.E.; Engineer, Douglas Aircraft Co., Inc.

Ballantoni, Joseph Henry, Design Engineer, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Bastedo, Walter, Jr., B.S. in Ae.E.; Aero. Research Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Bloomer, Harry Edward, B.S.M.E.; Aero. Engineer, Grade D-1, N.A.C.A.

Burke, Paul William, B.S.; Aviation Cadet, U.S. Army Air Forces.

Carey, Norman Wesley, B.S. in M.E.; Stress Analyst, Consolidated Vultee Aircraft Corp.

Chapel, Archie Timothy.

Clauss, James Thomas, B.S. in Ae.E.; Asst. Engineering Officer, U.S. Navy.

Cohen, Arnold H., B.S.Ae.E.

Cole, Henry Ambrose, Jr., B.S. in Ae.E.; Ensign, A(V)S., U.S. Navy.

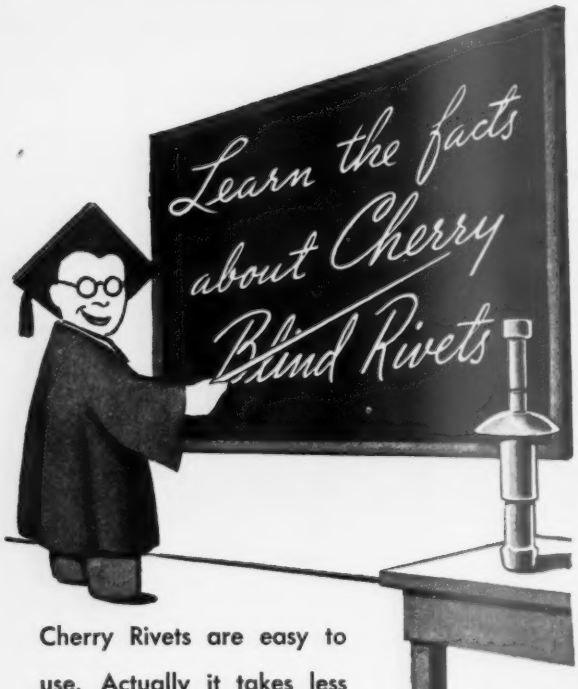
Corcoran, James Michael, B.Ae.E.; Aero. Engineer, North American Aviation, Inc.

Duggan, Walter Matthew, Shop Contact Man, Chance Vought Aircraft Div., United Aircraft Corp.

Erikson, Robert William, B.S. in M.E.; Ensign, U.S.N.R.

Fotieo, George, B. in Ae.E.; Engineer, Grumman Aircraft Engineering Corp.

Gialanella, Joseph, B. of Ae.E.; Stress Analyst, The Glenn L. Martin Co.



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Goodrich, Calvin, B.Ae.E.; Private, U.S. Army Air Corps.

Greenblatt, William, B.S. in M.E.; Loftsman, Consolidated Vultee Aircraft Corp.

Haueter, Paul Edward, B.S. in Ae.E.; Aerodynamicist, Stout Research Div., Consolidated Vultee Aircraft Corp.

Jockle, Philip Edward, Jr., Detail Designer, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Johnson, Roger Allen, B.Ae.E.; Project Engineer, Northwest Airlines, Inc.

Johnston, Edwin Wilbur, B.S. in M.E.; Jr. Aerodynamics Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Kleinman, Paul, B.Ae.E.; Layout Draftsman, Consolidated Vultee Aircraft Corp.

Kondoleon, Spero Anthony, B.A.E.; Major Detail Draftsman, Republic Aviation Corp.

Lifson, Melvin Wolfe, B.Ae.E.; Aerodynamicist, Consolidated Vultee Aircraft Corp.

McNeel, Harold Jordan, B.S. in Ae.E.; Engineering Draftsman, North American Aviation, Inc.

Meghreblian, Robert Vartan, B.Ae.E.; Jr. Div. Officer, U.S. Navy.

Minton, Stanley Joel, B.A.E.; Engineering Asst., Northrop Aircraft, Inc.

Nicholson John Hurt, B.A.E.

Simon, Jon, B.Ae.E.

Slade, Milton Herman, Design Engineer, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Smith, Bartlett Adams, B.S. in Ae.E.; Sr. Inspector, Boeing Aircraft Co.

Titus, Frederic Edwin, B.S. in Ae.E.; Aero. Engineer, Canadian Pacific Airlines.

Mrs. Florence S. Guggenheim.

Tucker, Beverley B., Officer Candidate, U.S.N.R.

Wolfson, James Alan, B. in Ae.E.; Aerodynamicist, Chance Vought Aircraft Div., United Aircraft Corp.

Ziino, Nicholas, Draftsman, The Glenn L. Martin Co.

Elected to Affiliate Grade

Cheaney, Thomas Frank, Engineer, Production Structures, Consolidated Vultee Aircraft Corp.

Duffy, Frank James, Jr. Engineer, Draftsman, Boeing Aircraft Co.

Evans, Elma Theora, B.S.; Librarian, Airplane Div., Research Lab., Curtiss-Wright Corp.

Goldberg, Max, Template Proofer "A," Brewster Aeronautical Corp.

Tamiso, Louis W., B.S.; Material Control Supervisor, B. H. Aircraft Co., Inc.

Necrology

Florence S. Guggenheim

Mrs. Florence S. Guggenheim, widow of Daniel Guggenheim, died Saturday, May 13, at her residence in New York from the effects of a heart attack suffered several months ago.

Mrs. Guggenheim had been active in many fields—in the continuation of the philanthropic activities of her late husband and members of his family; in aviation, where she carried on his interests; and in civic endeavors. In June, 1942, she donated her 162-acre Sands Point estate to the Institute, to be used to further the science of aviation, as a memorial to her husband.

Mrs. Guggenheim was born September 3, 1863, in Philadelphia. She was married there to Mr. Guggenheim on July 22, 1884. Surviving her are two sons and a daughter: Colonel M. Robert Guggenheim, of Washington, D.C.; Comdr. Harry F. Guggenheim, of New York and Port Washington, L.I.; and Mrs. Gladys Guggenheim Straus, of New York.

A. Leo Stevens

A. Leo Stevens, who had one of the longest careers in aeronautics in this country, died at the home of his brother

The residence of Daniel Guggenheim on the estate at Sands Point near Port Washington, L.I.

INSTITUTE *of the* AERONAUTICAL SCIENCES

1932–1944

Since its incorporation in October, 1932, as a scientific membership society to advance the art and science of aeronautics, the Institute of the Aeronautical Sciences, in over ten years of service to aviation, has become the representative technical society for the aviation industry and profession. It is the only organization in the United States which brings together all of the sciences and branches of engineering and technology which are applied to aeronautics.

Activities

In this year, coincident with the great increase in aeronautical production and research in the nation's war effort, the Institute is expanding its membership and activities in keeping with the greater demands made upon its services. Beginning with aeronautical students, the Institute has increased the number and activities of Student Branches. Members of the Institute in aeronautical centers are organized in local Sections which hold their own meetings. More of these Sections are being formed this year and additional services provided for members. The Annual Meeting and other national meetings provide forums where specialists in all the aeronautical sciences may present and receive reports on progress made in their particular fields and learn of developments in other fields that have a bearing on their own work. All meetings are held with proper safeguards to prevent any unauthorized publicizing of important information. Several annual awards and honors are conferred by the Institute to recognize and encourage outstanding achievement in the aeronautical sciences.

Publications

Papers presented at meetings or submitted to the Editorial Board are published in the Institute's two publications—the JOURNAL OF THE AERONAUTICAL SCIENCES and the AERONAUTICAL ENGINEERING REVIEW. The JOURNAL prints in each issue several full length scientific papers on new research and developments in various fields applied to aviation. The REVIEW keeps members and subscribers up to date on aeronautical news and literature through reviews of new books and periodical articles, government publications and trade literature and publishes papers on applied engineering and aircraft production.

Research Facilities

Through the Aeronautical Archives of the Institute, members have for their use the most complete aeronautical library and reference research facilities maintained by any technical society. At Institute headquarters in New York, the W. A. M. Burden Reference Library of books, reports and periodicals, the Aeronautical Index of subject files, biographic files and bibliography, and the historical and art collections in the Archives are available for study. The Pacific Aeronautical Library at 6715 Hollywood Boulevard, Los Angeles, maintains a reference collection and reading room for members and loans books to company libraries in the area. Through The Paul Kollsman Library, aeronautical books are lent by mail without charge to members anywhere in the continental United States. In addition to a very complete collection of standard aeronautical reference works, the Kollsman Library has available for loan new aviation books as they are reviewed in the AERONAUTICAL ENGINEERING REVIEW.

Membership

In addition to membership in professional societies representing their particular fields, specialists applying their knowledge and experience to aeronautics find membership in the Institute of great value in the contacts made with others engaged in aeronautical work and in the broad coverage of all aeronautical problems furnished through its meetings and publications. All applications for membership are carefully reviewed by the Admissions Committee, which recommends the grade of membership for which the applicant is found eligible. There are advanced grades of membership—Associate Fellow, Fellow, Honorary Fellow—to which members may be elected as their experience warrants. Thus, a member receives due recognition—more valuable because it is given by his colleagues—for his contributions to the progress of aeronautics. New applicants may be elected initially by the Admissions Committee to the grade of MEMBER if they are engineering graduates with at least three years of experience or have had over five years' experience in research, engineering, or other special work applied to aviation; to the grade of Industrial Member if they have acquired a recognized standing in an administrative capacity in the aviation industry; to the grade of Technical Member if they are recent engineering school graduates or are engaged in technical aeronautical work. For those interested or engaged in aeronautics or fields related to aeronautics who wish to participate in the activities of the Institute, the grade of Affiliate is provided. Student Members are admitted by application through Student Branches organized at their schools. Aeronautical companies, as well as individuals, are affiliated with, and participate in, the support of the Institute through Corporate Membership.

Dues

An entrance fee of $5.00 is required of all new members who apply for admission to a grade of membership to be specified by the Admissions Committee (Corporate Members, Student Members, and those who apply specifically for the grade of Affiliate being excepted).

Annual membership dues for the various grades of membership are as follows: Fellows—$15; Associate Fellows—$11; MEMBERS—$9.00; Industrial Members—$9.00; Technical Members—$5.00; Affiliates—$5.00.

The regular subscription price for the JOURNAL OF THE AERONAUTICAL SCIENCES and the AERONAUTICAL ENGINEERING REVIEW is $7.00 and $3.00 per year, respectively. Members may subscribe to the JOURNAL or the REVIEW or both at one-half the regular subscription rates.

Those who are engaged in aeronautical work or who have an interest in any technical phase of aviation will find the services of the Institute to be a necessary aid in keeping abreast of developments in these times of such rapid progress. An application form and further information about membership can be obtained from an Institute member or by writing to the Secretary.

INSTITUTE OF THE AERONAUTICAL SCIENCES

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at Bardonia, N.Y., on May 9, while en route from his home in Otsego County, N.Y., to Washington. He was a pioneer and a leader in lighter-than-air and a builder of balloons and parachutes. He made more than 1,000 exhibition balloon ascensions prior to 1900, with most of them ending in parachute jumps, and was the director of some of the first aeronautical races in the United States. He promoted many of the first long-distance flights in America.

Born in Cleveland, O., on September 27, 1876, he was in his sixty-seventh year. During his long career, Mr. Stevens' technical skill was demonstrated through the construction of airships, balloons, and parachutes. He was the holder of Pilot License Number 2 and had received many awards for his aeronautical accomplishments. At the time of his death he was actively engaged in developing parachutes as an aeronautical engineer with the Switlik Parachute Company.

Personnel Opportunities

This column is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Engineers—Aeronautical, Mechanical or Electrical; good opportunity available for designing and project development work. Must be citizen not employed in essential war industry or have proper certificate of availability. Write, giving full particulars including draft status to Box 212, Institute of the Aeronautical Sciences.

Aeronautical and Mechanical Draftsmen—must have general background. **Aeronautical Engineer**—with broad experience in aircraft maintenance or a general background in layout and design. **Mechanical Engineer**—with some experience in both steel and wood construction; also one Mechanical Engineer with some experience in electrical installations. All applicants must be eligible for Civil Service. Location: Florida. Include picture and all pertinent information as to age, education, and experience in first letter. Applicants must have certificate of availability. Address inquiries to Box 216, Institute of the Aeronautical Sciences.

Draftsmen—Detailers—Checkers—Stress Analysts, wanted by one of the larger aircraft accessories manufacturers. Excellent immediate and postwar opportunities. Plants located in southwestern Ohio. Address inquiries to Box 219, Institute of the Aeronautical Sciences.

Instructor, Assistant Professor, or Associate Professor of Aeronautical Engineering in large mid-western university to teach aerodynamics, preliminary airplane design, and aircraft detail design. Rank and salary depend upon qualifications. This is an opening with an excellent future and not a wartime emergency job. Address inquiries to Box 223, Institute of the Aeronautical Sciences.

Engineers—design, aeronautical experience necessary; particular reference to work in hydraulics and structural design; also engineering draftsmen with aeronautical background. Address inquiries to Box 228, Institute of the Aeronautical Sciences.

Engineer—Chief Design; graduate preferably with master's degree in heat transfer with a minimum of ten years' engineering experience on heat transfer equipment, such as heating and refrigeration coils, heat exchangers, unit coolers and heaters, air-conditioning equipment, and for other similar equipment. Permanent position having a bright future with a nationally known 50-year-old AAA1 cooling and heating equipment manufacturer in Buffalo, N.Y. Write in complete detail and confidence and enclose a recent photo (nonreturnable). Our engineers know of this advertisement. Address inquiries to Box 229, Institute of the Aeronautical Sciences.

Senior Mechanical Engineers, Junior Mechanical Engineers, Mechanical Draftsmen needed for new aircraft engine programs by an aircraft-engine company in the eastern area. Aircraft-engine experience preferred but not necessary if mechanical background is satisfactory. Proper clearance with the War Manpower Commission necessary. To arrange for an interview, please send your qualifications to Box 232, Institute of the Aeronautical Sciences.

Aeronautical Engineer—with at least three years' experience on aircraft stress analysis for stress analysis and special project work in the development of aircraft and associated products. Write, advising experience in detail, draft status, and salary requirements. Address inquiries to Vidal Research Corporation, Central Airport, Camden, N.J.

Aircraft Engineers—openings available in progressive Aircraft Company for layout and design engineers to cover Wing, Empennage, Power Plant, Fuselage, Electrical and Radio, Landing Gear, Hydraulics, Equipment, and Controls. Also openings for Tool Designers, Tool Planners, Production Planners, Loftsmen and Aircraft Drawing, and Template Checkers. Those presently employed in essential war work need not apply. Airmail complete detail information regarding education, experience, salaries, former employers, age, family status, citizenship, and draft status, in order that we may be able to evaluate your qualifications from the first letter. Address inquiries Higgins Aircraft Inc., P.O. Box 32, New Orleans 6, La.

Product Designers & Detailers—Work on small electromechanical, aeronautical devices. Excellent postwar prospects. Must comply with W.M.C. Address reply to: Lear Avia, Inc., Piqua, O., Att: R. J. Biggs.

Graduate Engineers for essential war work, opportunity for advancement and increased earnings. Aeronautical experience not necessary. Must be citizen not employed in essential war industry or have certificate of availability from the U.S. Employment Service Office or War Manpower Commission of your area. Write direct, stating school, age, degree, experience, draft classification, and marital status to Consolidated Vultee Aircraft Corporation, Industrial Training Division, San Diego, Calif.

Aeronautical Engineers with two or more years' experience in structural design and layout, or stress analysts, those with experience in the light aircraft field preferred, are urgently needed by Consolidated Vultee Aircraft Corporation, Stout Research Division. Must be referred through U.S. Employment Service. Write giving full particulars to Executive Engineer, 22148 Michigan Avenue, Dearborn, Mich.

Aeronautical Engineer wanted for promotional work in expanding line of highly specialized equipment for aircraft, also airway and airport control tower equipment. Must have extensive background in aircraft instrumentation, know the pilot's problems and the requirements of the air lines. Good basic knowledge in aerodynamics, physics and electronics necessary. Engineering sales and service experience contacting air lines and aircraft manufacturers desirable. Apply Wallace & Tiernan Products, Inc., Belleville 9, N.J.

Aeronautical Engineers urgently needed by Consolidated Vultee Aircraft Corporation, Fort Worth Division, to execute program of extensive development of large aircraft. Applicant must have technical training and not presently employed in essential war industries. Apply direct to 921 Lamar Street, Fort Worth, Tex.

Aeronautical Engineer—A graduate engineer, specialized in performance and range studies, who is currently up to date with latest developments in flaps, slots, and high lift devices. Position for future development. All inquiries treated confidentially. Applicant must offer a statement of availability. Submit résumé of education, experience and salary requirements to the Development Division,

I. A. S.

National Meetings Schedule

1944–1945

July 27–28, 1944
SUMMER MEETING — LOS ANGELES, CALIFORNIA

September 22, 1944
AIR TRANSPORT MEETING — WASHINGTON, D.C.

November 9–10, 1944
FALL MEETING — DAYTON, OHIO

December 17, 1944
WRIGHT BROTHERS LECTURE — WASHINGTON, D.C.

January, 1945
THIRTEENTH ANNUAL MEETING — NEW YORK

April, 1945
SPRING MEETING — DETROIT, MICHIGAN

The Officers and Council of the Institute invite participation in the Technical Sessions of the Meetings of the Institute.

The Meetings Committee will consider for inclusion on the program complete papers, or outlines or summaries of proposed papers.

Information for Participants

(1) Complete papers, or outlines or summaries should be submitted in triplicate at least four months prior to the meeting at which it is proposed to present the paper. Outlines or summaries should not exceed 1,000 words.

(2) Each paper should be so planned that it may be presented within a time limit of 45 minutes.

(3) All papers submitted will be considered for publication in the **Journal of the Aeronautical Sciences** or the **Aeronautical Engineering Review.** While a paper should be planned to take only 45 minutes for presentation at a meeting, the written presentation may have a maximum length of approximately 15,000 words.

(4) All material received will be submitted to the Meetings Committee. Authors will be notified, in ample time to prepare the complete paper, whether or not their papers can be scheduled for presentation.

All correspondence should be addressed to
The Meetings Committee
Institute of the Aeronautical Sciences
1505 RCA Building West
30 Rockefeller Plaza
New York 20, N. Y.

Fairchild Engine and Airplane Corporation, 30 Rockefeller Plaza, New York 20, N.Y.

AVAILABLE

Director of Quality, Chief Inspector for aircraft construction contact with Army or Navy (Navy preferred), 20 years' aircraft experience, also interested in aircraft maintenance, overhaul and repair. Address inquiries Box 230, Institute of the Aeronautical Sciences.

Aeronautical Stress Analyst—M.S. Ten years' well-rounded, aeronautical industrial experience; three years' teaching experience. Available July, 1944. Interested in research and development projects requiring special training and experience in airplane structures. Address inquiries to Box 227, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Graduate, age 30, at present Associate Professor of Aeronautical Engineering. Commercial experience in design criteria, wind-tunnel work and stress analysis. Desires responsible position in aircraft industry. Will be available about July 1. Address inquiries to Box 225, Institute of the Aeronautical Sciences.

Aeronautical Engineer, B. of Ae.-Eng., 35 years old, with teaching experience in Vocational Education and Aviation Maintenance. Desires position in Industry in East. Most recent experience doing technical writing and supervising of technical training with the Army Air Forces Technical School. Address inquiries to Box 224, Institute of the Aeronautical Sciences.

Aeronautical Engineer—15 years' experience, manufacturing military and commercial aircraft, air-line and military maintenance, development and research. Some experience with purchasing, plant layouts, teaching and plastics. Desires position with postwar future. Address inquiries to Box 221, Institute of the Aeronautical Sciences.

Experimental Flight Engineer, age 39, graduate, with well-rounded engineering background of 18 years' experience, desires permanent executive or technical position in middle or far west with established manufacturer or air line. Address inquiries to Box 220, Institute of the Aeronautical Sciences.

Structural Aeronautical Engineer—20 years' broad experience in all phases of military and commercial aircraft. Desires responsible position as development, liaison, or design project engineer with eastern company with postwar future. Certificate of availability after April 1. Address inquiries to Box 217, Institute of the Aeronautical Sciences.

Engineer, B.S. (C.E.) Univ. of Colo., 1938, research minded, desires connection in project engineering in air transport field or with progressive aircraft manufacturer. Two years' experience in project stress analysis and liaison stress work in aircraft manufacture, two years' investigation work for a state agency, one year with a leading structural design company. Address inquiries to Box 215, Institute of the Aeronautical Sciences.

Engineer, Graduate, Aeronautical, and commercial pilot, over 5 years' aircraft experience, including service as design, flight test, and project engineer, demonstration and check pilot, desires responsible position furthering use and expansion of this experience. Address inquiries to Box 211, Institute of the Aeronautical Sciences.

Consultant Aeronautical Engineer recently discharged Army Air Forces, formerly executive Chief Engineer, desires additional consultant work under contract. Address inquiries to Box 205, Institute of the Aeronautical Sciences.

Aeronautical Engineer, B.S. in M.E. (Aero Option), with over 5 years' experience in design and supervision wishes to become associated with a consulting engineer or group in the Philadelphia area. Address inquiries to Box 202, Institute of the Aeronautical Sciences.

Aeronautical Engineer, 15 years' practical and well-rounded experience in design supervision and executive, wide organizational and creative background as Project Engineer, Chief Design Engineer, Assistant Chief Engineer. Hard working. Release granted. Desires permanent position in the design or manufacturing branch. Location preferred, Los Angeles extended area or South America. Address inquiries to Box 153, Institute of the Aeronautical Sciences.

(*Continued from page 161*)

Aircraft Sheet Metal Work, Unit Course in Layout, Instructional Manual, prepared for the Air Service Command, U.S. Army Air Corps, in cooperation with the U.S. Office of Education, by the Utah State Board for Vocational Education; Salt Lake City, Utah, 1942; 1 vol.

Instruction Manual 104 in a series prepared for the Air Service Command of the U.S. Army Air Corps gives courses in sheet-metal layout. Like the other books in the series, this one is organized into three parts: job sheets, operation sheets, and information sheets. The job sheets provide specific assignments for a trainee to do, with instructions as to procedure in doing the respective jobs; the operation sheets provide additional detailed instruction on operations for jobs that require further explanation; the information sheets supplement textbooks, or serve in lieu of them when satisfactory textbooks are not available.

Aircraft Sheet Metal Work, Unit Course in Forming, prepared for the Air Service Command, U.S. Army Air Corps, in cooperation with the U.S. Office of Education, by the Utah State Board for Vocational Education; Salt Lake City, Utah, 1942; 1 vol.

A unit course in sheet-metal forming is given in No. 103 of the loose-leaf manuals prepared for use in training civilian mechanics employed by the Air Service Command of the U.S. Army Air Forces. The jobs sheets are divided into nine units on forming and 24 on fuselage section assembly; the operation sheets consist of seven units on forming, seven on bending, 14 on stretching, and four on bumping. Fourteen units on forming are contained in the information sheets.

First Aid and Military Sanitation, Tropical and Arctic Diseases; Army Air Forces Pre-Flight School (Bombardier-Navigator), Selman Field, Monroe, La., 1942; 1 vol.

An outline of six 1-hour lectures on first aid. The individual lectures deal with: (1) treatment of wounds and control of bleeding; (2) shock and head injuries; (3) fractures; (4) improvised traction splints, sprains and dislocations, and transportation of injured and wounded; (5) burns, sunstroke and heat exhaustion, freezing and frostbite, snake bite, insect bites and stings, and poisoning; and (6) airsickness

The Effect of Overstrain on Closely Coiled Helical Springs and the Variation of the Number of Active Coils with Load, by D. H. Pletta, S. C. Smith, and N. W. Harrison; Bulletin No. 24, Engineering Experiment Station, Virginia Polytechnic Institute, Blacksburg, Va., 1936; 30 pages, $0.20.

The results of a series of tests on closely coiled helical springs are given. These tests were conducted for the purpose of determining (1) the effect of overstrain beyond the elastic limit and (2) the variation of the number of active coils with the load on the spring.

(*Continued from page 177*)

Eight UAL Suggesters Win WPB Merit Awards. The following suggestions merited awards: (1) rollers for a Do-All saw table to prevent sheet metal from being scratched; (2) safety wrench for removing and installing oleo strut valve; (3) jig to hold tubular pieces of metal while they are being sawed with a flat band saw; (4) tool to facilitate the removal of cylinder base nuts during engine overhaul. *United Air Lines News,* April, 1944.

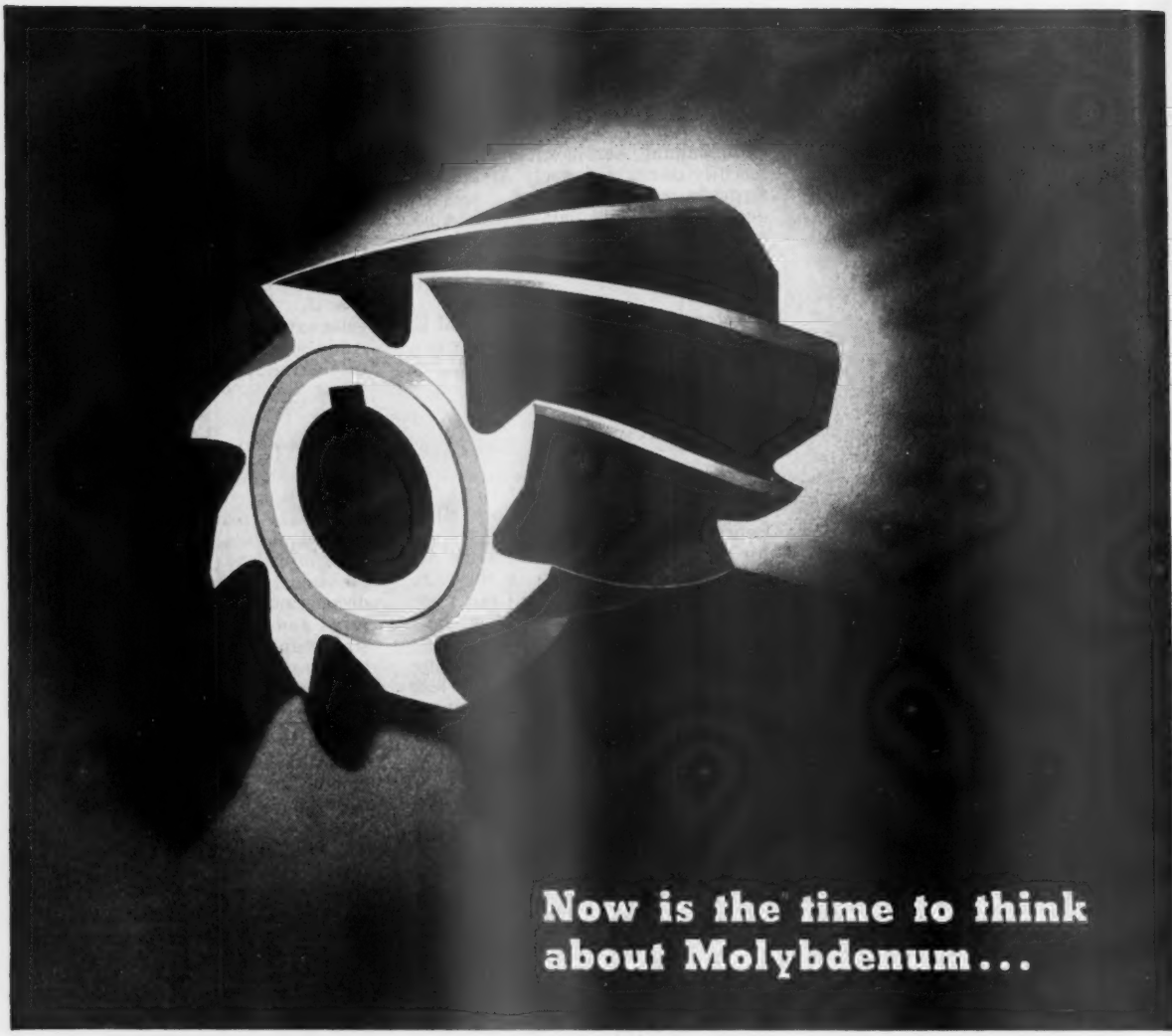
30 Suggestion Awards Made to Workers Here. Suggestions won awards as follows: (1) tool for installing rubber bumpers in cowlings; (2) improvement in cowl bracket. *FAD,* May 5, 1944.

Sturdivant Wins $150 in War Bonds for Top Suggestion Award of Week. The first prize in a weekly suggestion contest was won for a new mill fixture that gives more accurate part location and holds the part steadier. *Take-off,* April 28, 1944.

Lands $75 for a Tool Holder. A prize of $75 was given for a holder for circular form tools. *North Ameri-Kansan,* April 28, 1944.

Convair Workers' Suggestions to Save over 1400 Man Hours. The following suggestions won prizes: (1) special holder for sanding cowling links; (2) saw block for cowl plates; (3) device to mask neoprene wiper strip while spray-painting rudder; (4) special wrenches for inserting and ejecting anchor pins on engine cowl jig trim; (5) special rivet set for general squeezer in riveting bracket-idler pulley fuse in front bomb-door assembly; and (6) elimination of duplicate tooling on cowl panel. *Convair News,* April 21, 1944.

Award Winners for Production Suggestions Submitted in March. Suggestions that won awards in March were: (1) forming die for angle-reduction junctions on tail section reduces forming time from 20 man-minutes to 1 man-minute per airplane; (2) use of stop collars on twist drills used in drilling drain holes adjacent to trailing edges of control surfaces; (3) replacement of plunger and spring assembly in dual control by an AN bolt and self-locking nut reduces rework; (4) change in stock for spoiler push-rod assembly results in eliminating one bushing, two welding operations, and rework. *The Common-Ader,* April 27, 1944.



It is generally appreciated that the item of perishable tool costs is an important factor in manufacturing accounting. The possibility of savings offered by using molybdenum high speed steels, instead of tungsten types, is therefore worth consideration.

The savings are due first to the lower cost per pound of molybdenum steels, and second to their lower density. The latter results in more tools from an equivalent poundage.

The net savings effected naturally depend on tool performance. It is an established fact that, in a substantial majority of careful comparative tests made in the past, the performance of properly heat-treated molybdenum steels equaled, where it did not better, that of tungsten steels.

A consultation with your supplier should confirm these statements, but it would be a simple matter to check them in your own plant.

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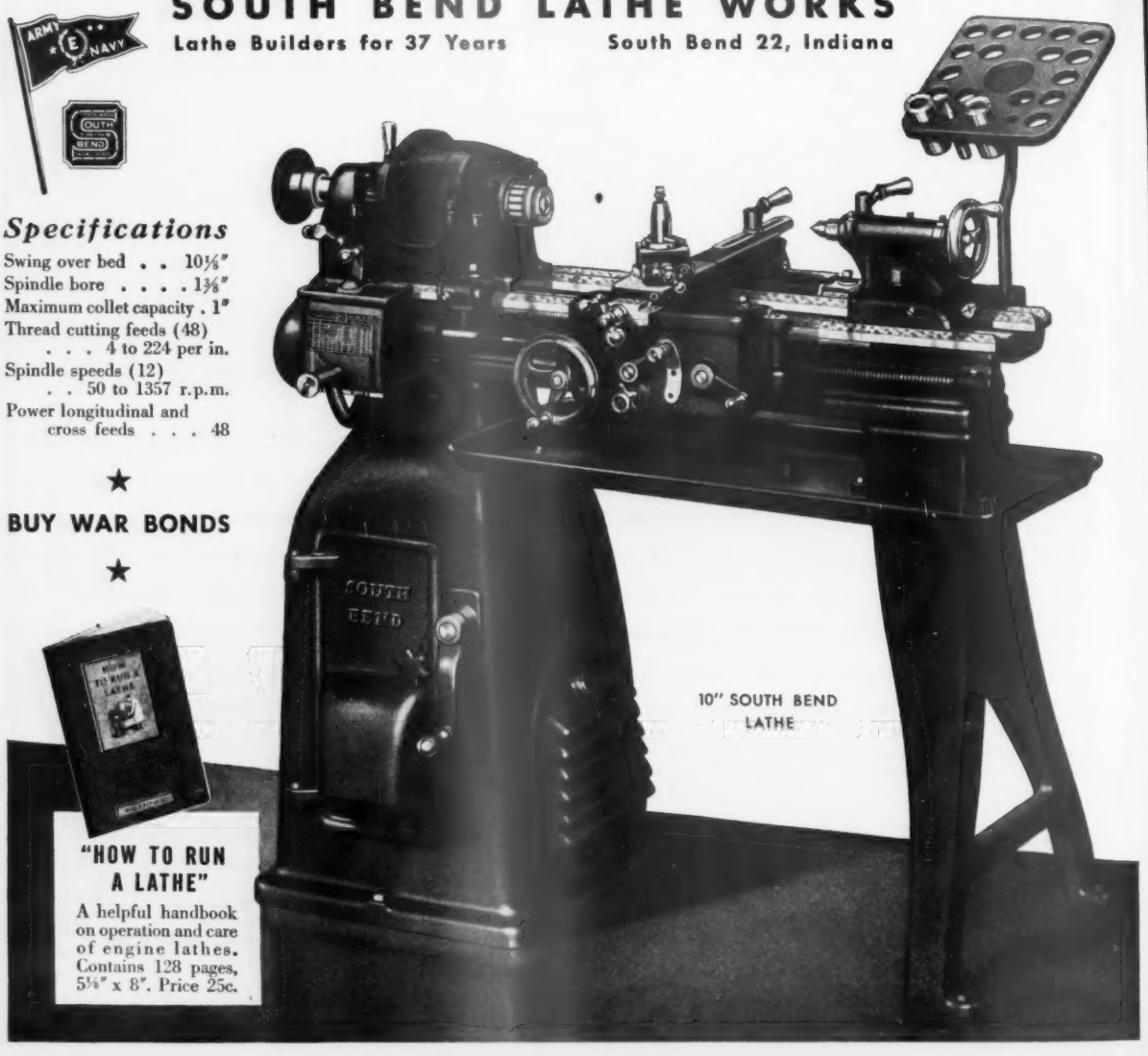

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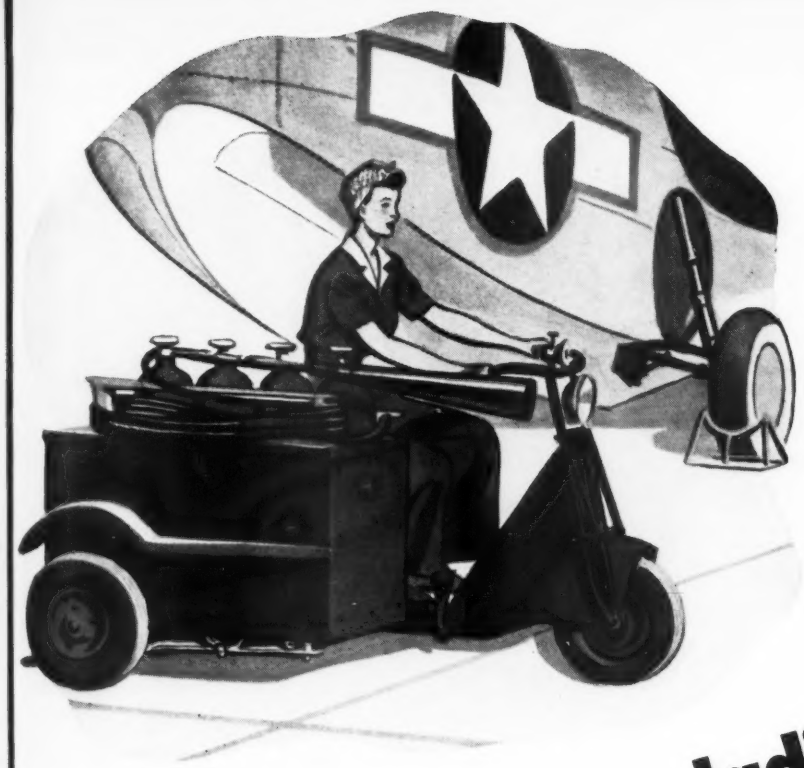

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